Demand and supply of natural rubber

Smit, H.P.

1981

DEMAND AND SUPPLY OF NATURAL RUBBER

- PART I -

Hidde P. Smit

Researchmemorandum 1981-2 January 1981

Economic and Social Institute
Free University
Amsterdam

Paper prepared for United Nations'
Economic and Social Commission
for Asia and the Pacific
Bangkok, November 1980

FOREWORD

The study on "Demand and supply of natural rubber" has as its objective: "to assess replanting and new planting policies as well as other aspects of a dynamic production policy for natural rubber and to indicate the policy that optimally meets future demand for natural rubber". It has been undertaken in the hope of reducing the degree of uncertainty facing rubber producers in the world rubber market. Although the primary audience for whom this study has been prepared are the natural rubber producing countries of the Association of Natural Rubber Producing Countries (ANRPC), its results should also prove of interest to synthetic rubber producers and even to rubber goods manufacturers.

The study is carried out at the Economic and Social Institute of the Free University at Amsterdam, commissioned by and in cooperation with the Economic and Social Commission for Asia and the Pacific (ESCAP). Financial assistance was given by the Netherlands Government. In completing this study, help and advice were received from a great number of organizations, private individuals and government officials throughout the world; the study would not have been possible without their direct and generous help.

This paper reports on part I of the study, which concerns the analysis of future demand for total rubber followed by a preliminary break down into natural rubber and synthetic rubber which then are compared to preliminary supply projection. Part II, which will be reported upon in a subsequent paper, will deal more in detail with prospective production (capacity) for natural and synthetic rubber and their share in total demand. Part II will be concluded with a simulation of future developments and an indication of the optimal dynamic production policy.

This report partly is a revision of the ESCAP paper: "Report on projections of demand for rubber", Bangkok, November 1978. The author is grateful for the many valuable comments received from participants during and after various meetings of the ANRPC and the International Rubber Study Group at which papers on the above subject were presented. Special thanks are due to my colleagues, both at ESCAP and the Free University, in particular Drs. Maria J.'t Hooft-Welvaars and Prof.Dr. F.C. Palm, to Dr. P.W. Allen of the Malaysian Rubber Producers' Research Association and to Dr. P.J. Watson of the International Rubber Study Group, who made substantial contributions to the research on which this paper is based.

It goes without saying that the study would not have been possible without the accurate and stimulating work by my subsequent assistants Naree Jongwattanatum and Erik P. Kroon and the patient efforts of everybody making the results of the study visible in this paper. A full description of the model in equational form will be available in due course.

CONTENTS

CONTENTS Page

Chapter 1. INTRODUCTION

1.1 The world rubber economy

The last decade of the century-long history of rubber use has been unusually turbulent for both natural rubber (NR) and synthetic rubber (SR). In the automotive sector, which absorps a major part of the world rubber supply, demand has been fluctuating as a result of the oil-crisis. Tire technology developments have changed the relative shares of demand for NR and SR. The oil-crisis has also had a different impact on the cost structures of natural and synthetic rubbers.

The growth of the world rubber economy was extremely rapid up to 1973, in large part owing to demand-pull, especially in the automotive sector. A major part of rubber demand arises in the automotive industry, primarily for tires but also to some extent for other automotive parts. The automotive industry in Western Europe and Japan enjoyed high rates of growth during the decade prior to 1973 because of economic growth and rapid penetration of passenger cars. In North America automotive use at a large scale had developed long before, but up to 1973 it continued to show a steady increase.

The oil-crisis of 1973 with its quadrupling of crude oil prices, as well as heavy price increases towards the end of the seventies had a sharp impact on both the demand and the supply sides of the world rubber economy. Increased prices of gasoline and doubts as to future availability of oil affected purchase and use of cars and commercial vehicles, although the short-term effect was far more important than the long-term effect because of overreaction in 1974-1975. This was enhanced by worsening traffic congestion and environmental issues. Automotive use was further influenced by a serious economic recession starting in 1974-1975 and by acceleration of world inflation. The drastic measures taken to combat inflation and their limited success deepened the already existing doubts about the long-term future of world development in general and the rubber industry in particular.

Added to the effects of the automotive sector, changes in the structure of the rubber sector itself were also substantial. Up to the Second World War, NR enjoyed a near-monopoly position; this position started to be challenged by SR in the 1940s as a result of war-time needs. Since the Second World War, NR's share in total world consumption has decreased steadily to about 30 per cent as a consequence of technological evolution of synthetic rubbers, improved competitiveness due to reductions in relative costs and better marketing methods of SR producers, vertical integration in the SR producing and consuming industries and insufficient availability of NR.

In the second half of the 1960s, the tendency in the tire industry to substitute SR for NR came to an halt owing to the introduction of the radial tire in Western Europe. The radial tire uses more NR than the conventional tire, which has been absorbing only a marginal NR content in the 1960s; however, the radial tire lasts 30 to 80 per cent longer than the conventional tire. In the 1970s the radial tire also penetrated in North America and Japan. The consequent reduction in the number of tires used during the life of a car or commercial vehicle has a major impact on rubber use in the automotive sector. The increase in NR content is extremely beneficial to NR producers at the expense of the SR industry, which has been hard hit by the reduced demand due to the combination of lower SR content per tire plus lower tire output.

The negative influence of the introduction of radial tires on the SR industry became even more pronounced in 1973 because the quadrupling of oil prices created a change of major proportion in the cost structure of SR, which depends heavily upon petrochemical feedstocks. NR was far less affected on the cost side because in its case only fertilizers, yield stimulants and wages are influenced by oil prices and inflation. The competitiveness of NR appears to have strengthened owing to these changes in relative production costs. Production possibilities of NR have improved remarkably as a result of research and development efforts pursued during the past 20 years. High yielding varieties of trees, improved tapping and processing techniques, technically specified rubbers and other marketing aspects can give huge productivity increases over the next decades if applied on a large scale. At the NR price side, the natural rubber price stabilisation agreement aims to achieve stable conditions in international natural rubber trade, by avoiding excessive price fluctuations by means of an international buffer stock of 550 thousand tons. The Agreement will enter into force on the 1st October, 1980, if ratified by a sufficient number of Governments.

1.2 The study

This study on "Demand and supply of natural rubber" has as its objective:

- to assess replanting and new planting policies as well as other aspects of a dynamic production policy for natural rubber and to indicate the policy that optimally meets future demand for natural rubber, if possible disaggregated by type -

In order to properly attain the objective of this study the following division can be made:

a - to analyze and forecast total demand for rubber by (group of) end-use(s);

b - to analyze current and prospective production (capacity) of rubber by type;

c - to assess the share of natural rubber by (group of) end-use(s) in relation to
   (1) technical aspects;
   (2) economic aspects;
   (3) availability of hevea and non-hevea types of rubber;

d - to simulate future developments and to indicate the optimal dynamic production policy for natural rubber.

The various parts will be elaborated below.

a - <u>Total demand for rubber</u>

Demand for rubber can be divided into two broad groups of end-uses: the tire sector and the rest to be called the non-tire sector (cf. tables A.1 to A.4 in the appendix).

Specific end-uses in the non-tire sector number in the thousands, many of which only consume a few tons a year. It is very hard to obtain adequate statistical information on the major end-uses; especially regarding use of rubber. Besides, there is much fluctuation in production as some end-uses disappear from the rubber scene while others enter. Therefore it has been decided to aggregate these non-tire end-uses.

The tire sector will be given more elaborate treatment. Demand projections can only be arrived at in stages: rubber is an input to tires; tires are attached to passenger cars and commercial vehicles, either for original equipment or for replacement; passenger cars and commercial vehicles, be they new ones or vehicles in use, can be explained from macro-economic and other variables. Changing this explanatory sequence into a causal chain by reversing the order of the above, the main segments of the tire sector forecasting methodology are discussed below.

The ultimate determinants of the over-all development of the vehicle, tire and rubber industries are population size, the level of and growth in income and the availability of energy. United Nations' Medium Variant projections of population growth will be used, if necessary, with some adjustments. Because future economic growth and availability of oil cannot be predicted at any reasonable level of accuracy, several scenarios of economic development and availability of energy will be introduced in the study. This range of possibilities offers users of our study the opportunity to select the scenario they believe most likely.

The second segment of the model for the tire sector deals with passenger cars and commercial vehicles. For the individual, to operate or not to operate a passenger car is a decision related to a variety of factors like traffic congestion, availability of public transport, distance between home and work, and the like; these factors are all intimately related with and dependent upon income. The number of passenger vehicles in use, then, can be derived from per capita income. The number of commercial vehicles, however, is more closely associated with level of industrialization and is thus better explained in terms of overall GDP.

The third segment of the model for the tire sector concerns changes in the existing stock of vehicles. On the one hand, increase in vehicles in use requires new registration of vehicles; on the other, replacement of discarded vehicles also requires new registration. New registration can therefore be divided into changes in the number of vehicles in use and replacements. Discards can be related to new registration in past periods. Average life of vehicles may be affected by such variables as economic development and availability of energy.

The fourth segment of the tire part relates to the demand for tires. After deriving the number of vehicles newly registered, the number of tires for original equipment can be estimated. An important but often overlooked variable in this regard is the number of tires per vehicle. For passenger cars prospects are for an increased use of "run-flat tires", thereby eliminating the spare tire. For commercial vehicles the number of tires per vehicle has increased in the past due to an increase in the market share of big trucks at the expense of medium-size ones; this trend seems to be flattening out, however, and it can thus be anticipated that the distribution of truck sizes will tend to remain stable in the foreseeable future.

Estimating the number of tires for replacement is a complicated matter. Two factors determine the rate of replacement of used tires: driving distance per vehicle per year and tire distance per set of tires. To generate realistic projections on this matter it is useful to deal with replacement rates as probability distributions; this method will be employed in the present study. In addition, driving distance per vehicle requires special consideration in view of recent developments such as availability of oil and increasing car density (which will have a negative impact on driving distance despite the fact that it is positively related to income, an ultimate determinant of increased rubber demand). And tire distance, too, is being influenced by a number of changing environmental parameters. Among the important variables are: safety regulations; driving style, with reduced speed limits, which has become particularly relevant after the oil crisis; size and weight of tires; and, most important, market penetration of radial tires, which increase tire distance by about 40-100 per cent. In addition it is important to recognize the changing role of remoulds, which may be more and more resorted to in order to save materials, energy and other increasingly costly inputs.

The final segment in the model concerns the demand for rubber itself as an input into the tire sector. This is essentially a direct relationship between the number of tires demanded and the rubber content per tire. Changing tire weights and sizes and ratios of rubber content play the critical role in this relationship.

Separate attention must be paid to those tires which are not attached to passenger cars or commercial vehicles e.g. for airplanes, motorcycles, bicycles, and off-the-road vehicles.

b - Production of natural rubber

In analyzing and projecting natural rubber production (cf. table A.5 in the appendix), one should distinguish between production and production capacity. The latter is related to the number and the type of rubber trees available, whereas production, involving the degree of capacity utilisation, is related to tapping behaviour including stimulation of the trees. Rubber prices and potential income from alternative types of employment appear on the scene. These topics are elaborated upon below.

Production capacity relates to a series of variables, the first of which is the type of clone or seedling,because various trees have different performances. A new high yielding clone produces many times the amount of rubber tapped from a pre-war tree. Not only average yield is important. Because trees can be productive for about 25 to 35 years and because production per tree is not independent of the age of the tree it is necessary to base an analysis of production capacity on

- yield curves as a function of the age of the trees, related to the type of clone
- area distribution of trees by type of tree and year of planting.

The above explanation of production capacity clearly points to a vintage model as the appropriate approach for these topics. This enables us to incorporate policies on replanting and new planting, which will only positively affect rubber production 4-7 years later. A further reduction in the average immaturity period may be achieved through improved technology and by spreading these improvement amongst smallholder through intensive extension work.

One way of extending production is increasing the area covered with rubber trees. Thus new planting gives a rise in production after 4-7 years. Before planting can be started, administrative procedures and physical clearing of the land will require quite some time. The opposite of new-planting is uprooting of rubber trees without replacing them with new rubber trees. The reason may be higher income earnings from alternative allocation of the area, or labour constraints.

Because productive life of a rubber tree is definitely limited to 25-35 years, it is necessary to cut down trees at the appropriate time and to replace these trees with new ones. The result of cutting down trees for replanting purposes is a decrease in production in the immediate future but an increase in the long run because replanting material will give a higher yield. The decrease in production will create a decrease in income for the smallholder whose rubber land is too small to spread replanting over many years. Various replanting schemes and aid programmes for smallholders try to give them income during the years of immaturity, thus allowing smallholders to replant their rubber land.

Application of the above described system of models may encounter serious obstacles for countries other than Maylaysia because of severe data limitations. For these countries, Indonesia, Thailand, India, Sri Lanka a.o., restrictions on parameters and simplification of the model may be necessary.

The degree of capacity utilisation, being defined the ratio of production and production capacity, is for a major part influenced by prices. This shows the way to simultaneously determining the effects of prices and capacity variables on production, thus providing us with a theoretical basis for fixing a series of figures for production capacity. Incorporated into this analysis may be such factors as use of fertilisers and stimulants. Parts of this may be included as embodied or disembodied technical progress in the production function determining production capacity.

c - Market share of natural rubber

In 1972 a study on competition between natural and synthetic rubber, entitled: "The techno-economic potential of NR in major end-uses" was undertaken by P.W. Allen, P.O. Thomas en B.C. Sekhar. It was published by the Malaysian Rubber Research and Devèlopment Board in 1974. The study started off with the observation that the current share of NR is below the potential share because of supply limitations and was based on the assumption that NR's potential market share is less than 100 % because of technical and economic considerations and due to various other economic/marketing disadvantages of NR.

For the base year (1970) the potential market share or "techno-economic norm" was derived for three regions:

USA	34 per cent
EEC	47 per cent
Japan	46 per cent.

Besides, it was assumed that the norm for the rest of the world, excluding the Centrally Planned Economy Countries, was 50 %. Calculating a weighted average resulted in a norm of 43 % for the world (excl. CPEC).

For the present study, NR's market share (cf. table A.6 in the appendix) should be assessed taking into account the following considerations:

a. In the past supply limitations of NR have been the major constraint in expansion of NR's market share. Thus, one might calculate NR's market share as NR supply over total rubber demand;
b. Any techno-economic norm for NR should be interpreted as a techno-economic norm for isoprenic including such rubbers as cis-polyisoprene and guayule;
c. Such a techno-economic norm can only be reached by NR if it is sufficiently available at competitive and reasonably stable prices with appropriate marketing arrangements and without such heavy barriers as captive markets and political protection for synthetic rubbers;

d. The techno-economic norm is only relevant at an end-use level. Any aggregation presupposes no changes in the composition of aggregate production of rubber manufactured goods. The shift to radial tyres e.g. increases the norm. Further penetration of remoulded tyres decreases the norm because only the thread is replaced, which virtually only consists of synthetic rubber.

Reviewing the above considerations the study will simultaneously assess supply of NR and other rubbers, market share of NR and prices of NR and various synthetic rubbers. Of course, elements of cost prices of NR and SR will be taken into account including oil prices and inflation.

d - Simulation of future development and indication of an optimal dynamic production policy.

By now the structure of the study has been described. The last part on simulations in order to obtain an optimal dynamic production policy, follows the same structure:

a. project future rubber demand by end-use on the basis of expected economic development, oil prices, availability of energy and changes in other variables, included in the model;
b. project production (capacity) of NR and other rubbers, simultaneously with prices and market shares; all of this can only be done on the basis of a priori given new-planting and replanting policies, which, of course cannot be treated separately from developments in the rest of the economy;
c. assess market developments derived from b. and c. and indicate the optimal new-planting and replanting policy; afterwards disaggregation of demand and supply by type might be incorporated.

1.3 This paper

As has been stated in the foreword, this paper reports on part I of the study, which concerns the analysis of future demand for rubber, followed by a preliminary breakdown into demand for natural rubber and demand for synthetic rubber which then are compared to preliminary supply projections. The next paper, reporting on part II, will then more in detail analyze future production and perspective consumption shares for natural and synthetic rubber, and will finally give some policy recommendations.

This paper has the following broad table of contents.

<u>Chapter</u>

Chapter 2. THE MACRO SCENE: REGIONAL CLASSIFICATION, POPULATION, INCOME AND ENERGY

2.1 Regional classification

Analyzing demand and supply of rubber requires information on world aggregates. However, information on world aggregates can only be obtained by adding information on smaller parts of the world, as different parts of the world act and react differently. Optimally the study might do the analysis at the country level. However, parameters indicating behaviour may be about the same for countries and/or data may not be available to do an analysis at the country level.
This means that in our study, there will be as much aggregation as feasible and realistic and as much disaggregation as necessary in view of work load and relevance for the results of the study.

The above implies that different parts of the analysis, may require different ways of aggregation and different ways of classification by region. The highest level of disaggregation of the world into regions is indicated in table A.7. A high level of disaggregation is required for such parts of the study as income growth, ownership of passenger cars and commercial vehicles and production of rubber. A more aggregated approach can be used e.g. for scrapping behaviour, tire life and natural rubber content per end-use.

2.2 Scenarios for population, income and energy

Any model deals with two types of variables: variables, whose development are explained by the model (e.g. rubber demand, car ownership, natural rubber production) and variables which are very important to the model but whose development must be analyzed in a greater context (e.g. income growth, driving distance and rubber technology). Some of these variables basically are macro scale variables and will be discussed in this chapter.

The ultimate determinants of world demand for rubber are population, national incomes and their respective growth rates. The basic connection between these key variables and such rubber-using products as vehicles, tires and other rubber goods is self evident. Projections of these fundamental demand determinants is however the most vulnerable part of rubber demand projections. The plausibility of the assumptions with respect to population and income growth determines the validity of the result of any study.

a. Population

The population projections used in the present study are the so-called United Nations medium variant, as adjusted in certain cases by other international organizations (see United Nations, Population Division (1975)). Some further adjustment have been included by us to account for recent developments in population growth. Detailed projections are given in table A.8. A summary for XII broad regions is given below in table 2.1.

Table 2.1 Population estimates and projections by broad regions (in millions)

		1975	1980	1985	1990	1995	2000
I.	North America	236.3	246.2	257.7	268.4	276.8	284.4
II.	Asia, developed	111.6	117.0	120.7	123.2	125.2	127.2
III.	Oceania, developed	16.8	17.7	18.5	19.2	19.7	20.1
IV.	North-West Europe	233.6	234.4	235.3	236.5	237.4	237.8
V.	South-West Europe	172.3	182.4	193.3	204.7	216.1	226.8
VI.	Eastern Europe	363.0	378.9	394.7	409.0	421.8	434.4
VII.	Latin America+Carr.	317.6	364.1	416.9	475.8	539.7	608.0
VIII.	Asia, Centr.Planned	987.3	1056.9	1121.5	1176.9	1231.3	1283.7
IX.	South Asia	806.4	897.5	996.4	1098.6	1197.9	1290.6
X.	South-East + E.Asia	293.7	329.6	368.1	407.3	445.3	480.7
XI.	Middle East+ N.Afr.	130.7	149.4	170.1	193.1	217.1	241.2
XII.	Other Africa	321.2	370.7	430.4	501.1	584.4	679.6

b. Income

There is considerable controversy over the future of world income levels. Because of this controversy surrounding such long-term projections, we have devised three alternative scenarios of future economic growth, projecting Gross Domestic Product (GDP) in 1975 constant $ U.S. by country or region:

Scenario G1 - low rate of economic growth

G2 - medium rate of economic growth

G3 - high rate of economic growth.

The assumptions behind these scenarios are as follows:

- growth figures for 1980 are based on recent OECD projections and/or on the pattern of recent years;
- all growth figures for 1981 and later are rounded at 0.5 %;
- growth figures for 1981 are assumed to be
  - slightlyless or equal to 1980 for G1, except for USA and UK
  - close to 1980 for G2
  - slightly higher than 1980 for G3;
- growth figures for the following years are assumed to increase, reaching a maximum around 1990 with low, medium and high levels for G1, G2 and G3 res pectively.

The advantage of these alternative scenarios in projecting world demand for rubber is that they permit the individual reader:

a. to include his own views concerning the future of the world economy into his projection-based decisions,
b. to adjust his choice of projection as new information on the world's economic future becomes available, and
c. to find out how sensitive the demand for rubber is to the rate of economic growth.

The three projected GDP scenarios are presented in table A.9.
A summary for the XII broad regions is given in table 2.2 below. To complete the picture, estimates and projections of GDP per capita in constant 1975 $ U.S. are presented in table A.10 and summarized below in table 2.3.

Table 2.2 Growth in gross domestic product, estimates and scenarios (in 1975 constant $ U.S.).

			Compound annual growth rates				
			1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
I.	North America	G1	3.1	.3	1.6	1.6	1.1
		G2	3.1	1.4	3.1	3.1	2.6
		G3	3.1	2.2	4.1	4.1	3.6
II.	Asia,developed	G1	5.7	4.0	4.5	4.5	4.0
		G2	5.7	4.9	6.0	6.0	5.5
		G3	5.7	5.7	7.0	7.0	6.5
III.	Oceania, developed	G1	2.6	3.0	3.3	3.3	2.8
		G2	2.6	3.8	4.8	4.8	4.3
		G3	2.6	4.6	5.8	5.8	5.3
IV.	North-West Europe	G1	2.9	2.1	2.9	3.0	2.5
		G2	2.9	3.0	4.4	4.5	4.0
		G3	2.9	3.8	5.4	5.5	5.0
V.	South-West Europe	G1	3.3	1.8	2.5	2.6	2.1
		G2	3.3	2.7	4.0	4.1	3.6
		G3	3.3	3.5	5.0	5.1	4.6
VI.	Eastern Europe	G1	3.8	3.3	4.0	4.0	3.6
		G2	3.8	4.2	5.5	5.5	5.1
		G3	3.8	5.0	6.5	6.5	6.1
VII.	Latin America + Caribbean	G1	4.3	3.8	4.6	4.8	4.4
		G2	4.3	4.7	6.1	6.3	5.9
		G3	4.3	5.5	7.1	7.3	6.9
VIII.	Asia, Centr. Planned	G1	4.9	5.1	5.8	5.9	5.4
		G2	4.9	6.0	7.3	7.4	6.9
		G3	4.9	6.8	8.3	8.4	7.9
IX.	South Asia	G1	5.3	4.8	5.5	5.5	5.0
		G2	5.3	5.7	7.0	7.0	6.5
		G3	5.3	6.5	8.0	8.0	7.5
X.	South-East + East Asia	G1	7.7	5.6	6.3	6.4	5.9
		G2	7.7	6.5	7.8	7.9	7.4
		G3	7.7	7.3	8.8	8.9	8.4
XI.	Middle East + North Africa	G1	4.6	3.2	4.0	4.1	3.7
		G2	4.6	4.1	5.5	5.6	5.2
		G3	4.6	4.8	6.5	6.6	6.2
XII.	Other Africa	G1	1.9	1.0	1.8	1.8	1.4
		G2	1.9	1.9	3.3	3.3	2.9
		G3	1.9	2.7	4.3	4.3	3.9

Table 2.3 Gross domestic product per capita, estimates and scenarios

(in 1975 constant $ U.S.)

			GDP per capita					
			1975	1980	1985	1990	1995	2000
I.	North America	G1	7.164	8.024	7.769	8.076	8.479	8.724
		G2	7.164	8.024	8.234	9.209	10.403	11.520
		G3	7.164	8.024	8.563	10.051	11.916	13.851
II.	Asia, developed	G1	4.371	5.502	6.490	7.925	9.716	11.637
		G2	4.371	5.502	6.776	8.885	11.697	15.050
		G3	4.371	5.502	7.038	9.673	13.346	18.001
III.	Oceania, developed	G1	6.072	6.581	7.291	8.289	9.484	10.666
		G2	6.072	6.581	7.611	9.290	11.437	13.827
		G3	6.072	6.581	7.905	10.119	13.063	16.566
IV.	North-West Europe	G1	5.982	6.862	7.581	8.714	10.044	11.337
		G2	5.982	6.862	7.928	9.795	12.135	14.726
		G3	5.982	6.862	8.240	10.677	13.873	17.660
V.	South-West Europe	G1	2.220	2.468	2.549	2.723	2.928	3.100
		G2	2.220	2.468	2.664	3.060	3.537	4.028
		G3	2.220	2.468	2.769	3.337	4.046	4.833
VI.	Eastern Europe	G1	2.088	2.416	2.721	3.194	3.772	4.365
		G2	2.088	2.416	2.842	3.593	4.545	5.651
		G3	2.088	2.416	2.953	3.912	5.189	6.764
VII.	Latin America + Caribbean	G1	1.077	1.159	1.217	1.338	1.490	1.643
		G2	1.077	1.159	1.271	1.500	1.793	2.123
		G3	1.077	1.159	1.320	1.632	2.045	2.537
VIII.	Asia, Centr.Planned	G1	.318	.377	.455	.576	.732	.913
		G2	.318	.377	.475	.645	.880	1.177
		G3	.318	.377	.493	.701	1.002	1.405
IX.	South Asia	G1	.145	.169	.192	.227	.272	.322
		G2	.145	.169	.200	.254	.327	.415
		G3	.145	.169	.208	.277	.372	.496
X.	South-East + East Asia	G1	.394	.509	.599	.736	.916	1.130
		G2	.394	.509	.624	.823	1.100	1.455
		G3	.394	.509	.648	.895	1.252	1.735
XI.	Middle East + North Africa	G1	1.666	1.823	1.874	2.012	2.187	2.356
		G2	1.666	1.823	1.957	2.257	2.635	3.049
		G3	1.666	1.823	2.019	2.443	2.991	3.631
XII.	Other Africa	G1	.427	.407	.369	.346	.324	.298
		G2	.427	.407	.385	.389	.392	.388
		G3	.427	.407	.401	.424	.449	.467

c. Energy

The last part of our macro scene is the energy aspect. For passenger cars, commercial vehicles tires, rubber etc. the availability and the price of oil are the most important elements of the energy aspect.

We shall just mention a few sections of the analysis where energy may come to the forefront.

a - economic growth

b - passenger car and commercial vehicle park

c - driving distance and discarding

d - driving distance and tire wear

e - increased usage of remoulded tires

f - production costs and, thus, prices of SR

g - prices and production costs of NR.

It needs no further clarification that it is very hard to include the energy aspect accurately into the model because

- it is not clear what the relationships are
- it is not clear what the future of energy will be.

For example, energy availability and price affect GDP growth which in turn influence passenger car ownership. But passenger car ownership may be more sensitive to energy (oil) availability than GDP in general. On the other hand, perhaps driving distance rather than car ownership is affected by oil availability and price.

Consequently, quantifying energy scenarios, as has been done above for GDP, and determining exact relationships with variables like driving distance, seems an impossible venture. We shall therefore confine ourselves to qualitatively mentioning energy (oil) scenarios and assume possible effects wherever necessary. These scenarios may be described along the following lines:

scenario	availability	price
E1	low	high
E2	high	low

Further details shall be tentatively quantified wherever necessary in the subsequent chapters and projections. It goes without saying that not all combinations of GDP scenarios G1, G2 and G3 and energy scenarios E1 and E2 are realistic. E1 might be combined with either G1 or G2 and E2 might be analyzed together with G2 or G3.

Chapter 3. THE PASSENGER CAR MARKET

3.1 Introduction

About two-thirds of total rubber use goes into tires, these tires being attached to vehicles. Both differences in use of particular types of vehicles, and the availability of data, lead to distinguishing three categories:

- passenger cars
- commercial vehicles
- other vehicles.

The latter category consists of such types as motorcycles, bicycles, airplanes, earthmovers and other off-the-road vehicles. A striking lack of appropriate data and a low share of world rubber consumption made it clear that this category should be treated separately and can only be handled in a way which is rather similar to the non-tire sector to be discussed in another chapter.

In developing models and consequently setting up projections for rubber demand, attention should be focussed on those factors concerning vehicles (passenger cars and commercial vehicles) which determine tire purchase and use. Tires are bought when attached to a new vehicle or to replace worn-out tires. Thus, emphasis must be placed on:

- how many vehicles are purchased in order to determine the number of tires for original equipment;
- how many vehicles have driven how many kilometres and when will they consider their tires worn-out.

Analyzing the vehicle market as a whole for each country or region, certain closely related statistics are relevant:

- production of vehicles
- inventories of vehicles
- sales of vehicles
- new registration of vehicles
- total registration of vehicles (vehicles in use)
- discards of vehicles
- international trade in vehicles
- trade in used vehicles.

Different combinations of these statistics are available for different countries, providing a variety of approaches to developing models and conditional projections. The causal order among these variables has to be determined to derive a consistent and comparable set of data for model building and projection making. To avoid overloading the model, variables with little meaning in determining tire demand, will be omitted, unless they are essential in modeling the vehicle market.

First, as we may assume that trade in used vehicles will not affect use of tires we do not include this in the model. There may be a general tendency for old vehicles to drive slightly less than new vehicles, thus wearing tires out at a slower pace. However, this is too elaborate to be included. Second, international trade in vehicles roughly fills the gap between production of vehicles per country and purchase of vehicles per country. Because tires for replacement, as a major part of total tire consumption, is related to registration of vehicles and driving habits per country, it is more accurate to analyse tire usage in the country where the vehicle is purchased rather than in its area of production. Third, for the same reasons as above, production of vehicles is not relevant because the goal is to construct world-aggregate rubber demand by aggregating rubber demand per country to be arrived at as accurately as possible. Fourth, our model has to be a long-term one in order to arrive at conclusions about new planting and replanting of rubber trees, which have an immaturity of 4-7 years and will go on producing for some 30 more years. It is therefore not necessary to pay much attention to inventories of vehicles, as results of intertemporal and interspatial discrepancies between short-term demand and supply. Fifth, on sales of vehicles, reliable aggregate data are available for a few countries only. A more reliable data series which should represent the same variable is new registration.

This brings us to the relation between the remaining variables: vehicles in use, new registrations and discards. A newly registered vehicle may be purchased for two reasons: either because a person wants one (more) vehicle, not having one (or enough) or because he wants to replace a vehicle he is already using. The first case requires an increase in the "vehicle park"; the second case requires that the old vehicle will be sold to someone wanting to use one (more) vehicle or to replace one he already uses. Replacement (the second case) goes on until the last person in line only has the option of discarding (i.e. scrapping) his old vehicle or adding one more to his existing stock; the net result of the replacement sequence must therefore be discards. If a vehicle is discarded without being replaced, the number of vehicles in use will be reduced. The only problem is international trade in used cars. This is rather minor and does not disturb the picture. Thus, new registration can be divided into increase in the vehicle park and discards. This fact implies that it is not appropriate to explain new registration using a behavioural equation because it consists of a mix of elements with changing content. Discards are related to lagged values of new registration. A model of this relationship will be developed.

3.2 Modeling passenger cars in use

In this section we will deal more in detail with the following aspects of the stock demand model:

- income, income distribution and diffusion (see below)
- saturation and long term developments.

a. Income, income distribution and diffusion

The relationship between the number of cars in use and income has been treated by Fauré (1959) in a so-called "diffusion model" in which ownership-rates are expressed as a function of income per family.
Basis of this analysis is the assumption that for the individual family i to have or not to have a car is a simple stepfunction with value 0 if actual income y_i is less than threshold income y_{i0} and with value 1 if $y_i \geq y_{i0}$.
Aggregating this for groups of families in some income class gives the percentage of families owning a car. For very small income brackets the thus developed "continuous" curve resembles figure 3.1.

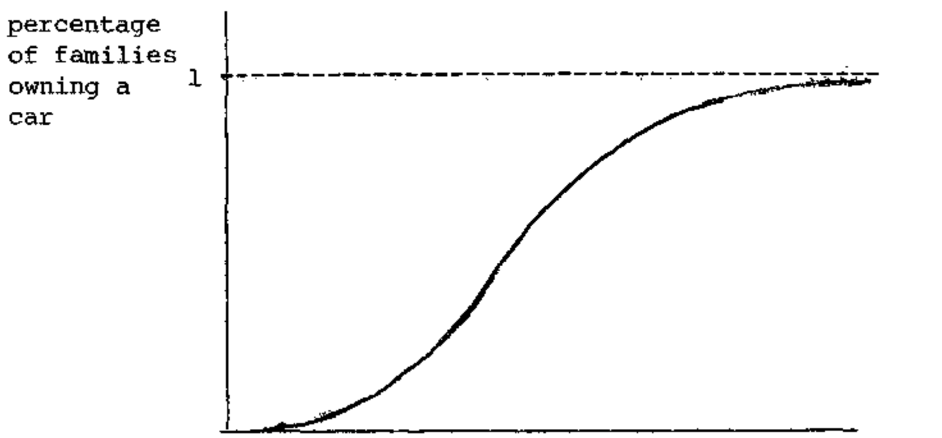


Figure 3.1

A thorough analysis of the diffusion process and the resulting development in the stock of cars is done by Bonus for West Germany (1973). He divides diffusion into two stages. The first is vertical diffusion, the underlying learning process: the household becomes sufficiently aware of the commodity to desire its ownership. They become potential owners. However, if their critical income for buying the commodity still is above their actual income, they will not yet become actual owners. The second stage is horizontal diffusion: their critical income may be reduced because their desire to own the good is intensified.

Bonus thus arrives at three reasons for growth

- vertical diffusion growth: an increase in the fraction of potential owners;
- horizontal diffusion growth: a decrease in the critical income level, which may also occur through relative price decline of cars, quality improvements and better supply conditions;
- income growth: an increase in the level of income will lead to greater car ownership, depending on the income elasticity of demand.

Bonus then derives the form of aggregate growth curves for the above types of growth. It can be concluded that a logistic or "normal" growth curve, be it skewed or not can be caused by income increase, vertical diffusion (learning), horizontal diffusion (shift in critical income)and more attractiveness because of prices, supply and quality, but presumably by a mixture of all these factors. The learning aspect introduces skewness. Distinguishing between income effects and diffusion requires at least one cross-section in addition to the time series data.

In a study on consumer demand for cars in the USA, Smith (1975) sets off with the observation that income is the major variable explaining car ownership. Selling prices of cars can not be expected to be significant, because in total running cost, the capital outlay may be of minor importance. Moreover, it is possible to buy a cheaper car, if price is a bottleneck for car purchase. Demographic, geographic and socio-cultural factors are important for cross-sections over regions etc. but rather unimportant for time series analysis and, besides, hard to predict. In our opinion Smiths observations are very relevant and will also be elements of the set of assumptions underlying the model, to be presented in sections 3.4 and 3.5.

b. Saturation and long-term developments.

In the studies by Bonus, Smith a.o. saturation levels have been fixed exogenously, in most cases equaling unity: each family a car, or more than unity in case multiple car ownership was not treated separately. Many other studies, trying to estimate demand equations for cars, including a saturation level, used car ownership per capita or for instance per 1000 persons. As early as in 1938 De Wolff (1938) published an article presenting the results of an examination of the factors which determined the demand for motor cars in the USA. Demand for replacement and demand for first purchase is treated separately. Demand for first purchase is analyzed using figures for 1905 - 1934. The logistic curve is chosen to explain the number of cars (not corrected for population size) as a function of time. The estimated saturation level of 22.8 million roughly means 1 car per family if population size and family size of the thirties are used. The current figure of over 100 million cars may partly be explained from such factors as further diffusion, multiple car families, increase in population and reduction in family size.

A study on a logistic approach to the demand for private cars for the Netherlands was done by Bos (1970). The logistic curve

$$y_t = \frac{k}{1 + m\, e^{bt}} \tag{3.1}$$

with saturation level k, suffers from a few disadvantages:

- it is only a function of time
- it is "symmetric": the levelling off phase shows the same shape as the beginning phase
- it is very hard to obtain reasonably accurate estimates of the parameters, in particular the saturation level k, unless developments are far beyond the point of inflexion.

The above objections have not been satisfactorily eliminated by Bos by introducing income I_t and prices P_t

$$y_t = y_o + \frac{k}{1 + m\, e^{bt+cI_t+dP_t}} \tag{3.2}$$

Parameter estimates are extremely sensitive to the length of the sample period: "how long is the linear part".

A better fit than the logistic offers, may be achieved by the Gompertz-curve (cf. Davis (1941) and Nowicki (1969))

$$y_t = k\, a^{b^{x_t}} \tag{3.3}$$

with k = saturation level and x_t is some variable e.g. income. This may be skew and may include income as explanatory variable. Yet, the Gompertz-curve is less popular than the logistic curve. Our own choice will be given in section 3.5.

3.3 Historical developments and model specification

Population growth is of course one of the basic reasons for growth of the number of cars in use. The population aspect can be entered in two ways: cars per 1000 persons or cars per family or household. The first concept has been preferred because

- the number of households or families is more uncertain than the size of the population;
- it is difficult to project the number of households or families;
- the definition of household or family is different between countries, and changing over time.

Car ownership is distributed extremely unevenly between countries. Levels of car ownership for 5-year periods from 1950 onwards are presented in table A.11 as much as possible or relevant on a country level.

A graph representing the number of cars per thousand persons over time, shows the following three phases (figure 3.2).

- an increasingly upward oriented phase ($t < t_1$)
- a linear part ($t_1 < t < t_2$)
- a levelling off phase ($t > t_2$)

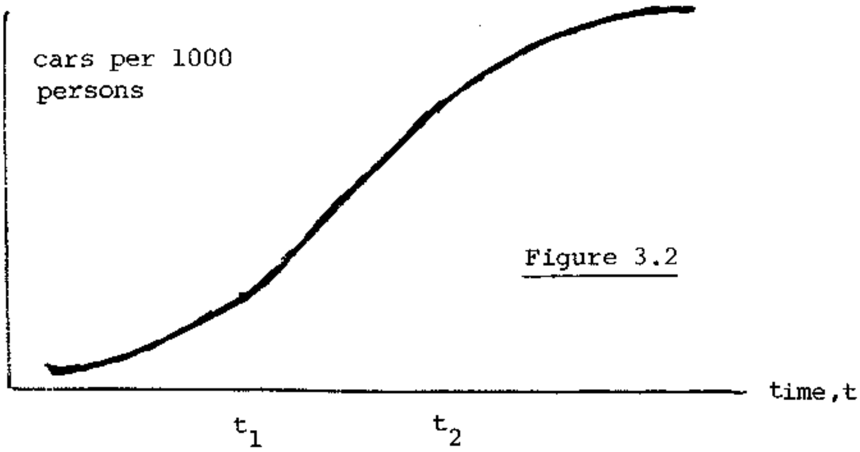


Figure 3.2

As an illustration we present graphs for a few countries below:

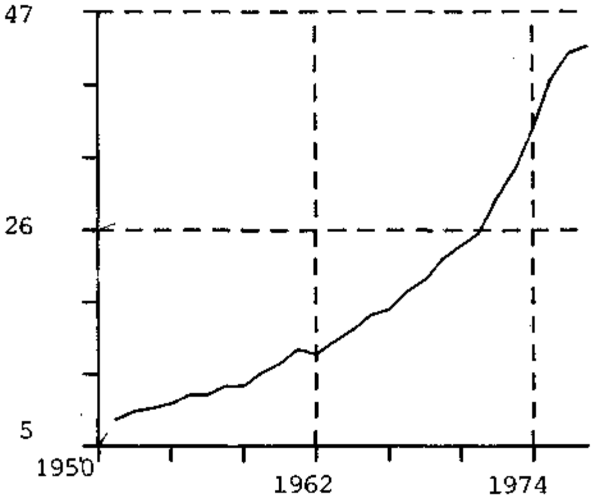
- Mexico : has the 1st phase already ended? (cf. figure 3.3a).
- Netherlands : transition from phase 1 to phase 2 was in the early sixties at a degree of ownership of about 80 cars per thousand inhabitants; the 2nd phase is still continuing (cf. figure 3.3b).
- United States : the period 1951-1977 must be considered as fully belonging to phase 2; the sample period does not show the beginning or the end of phase 2 (cf. figure 3.3c).
- United Kingdom : considering 1951-1970 as sample period one should expect a nice logistic curve; however, the early seventies did not show a continuing levelling off tendency, whereas, from 1974 onwards, the change in direction must, at least partly, be attributed to the oil crisis (cf. figure 3.3d).
- Italy : a rather smooth development; transition from phase 1 to phase 2 in the early sixties and about 10 years later transition from phase 2 to phase 3 (cf. figure 3.3e).

Some impression about the period of transition from one phase to the next, is given in table 3.1 for many of the relevant countries (columns 1-5). From this table we may draw the following conclusions:

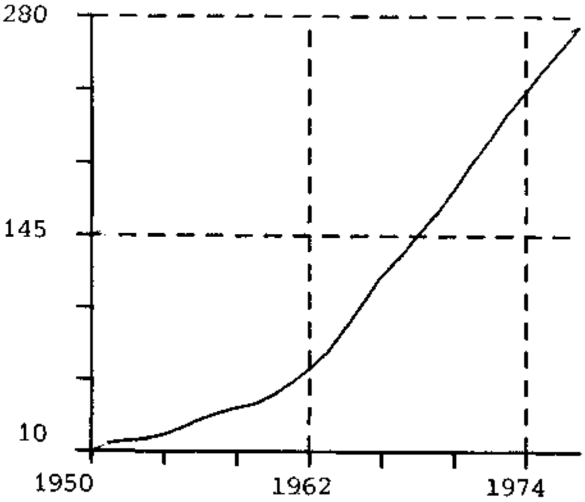
- some countries may be called early starters: a level of over 100 cars per 1000 persons back in 1951 and phase 2 stretching from before 1951 still beyond 1977; this group consists of USA, Canada, Australia and New Zealand;
- most European countries started phase 2 in the early sixties; exceptions are early starter Sweden and some southern European countries;
- Japan is a special case: a spectacular growth from 1 car per 1000 persons in the early fifties, 10 cars in the early sixties, 100 cars in the early seventies and 200 cars in the late seventies.

Implications of the above considerations are:

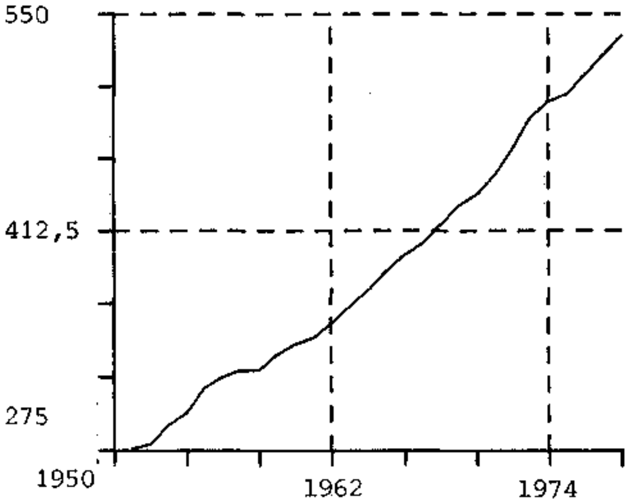
- it is impossible to estimate saturation levels from time series data;
- it is irrealistic to apply such models as simple logistic curves or logits as functions of time only;
- it is not appropriate for the long term to apply a specification in which no saturation level is included, unless the country or region is at a very low level of car ownership per 1000 persons.



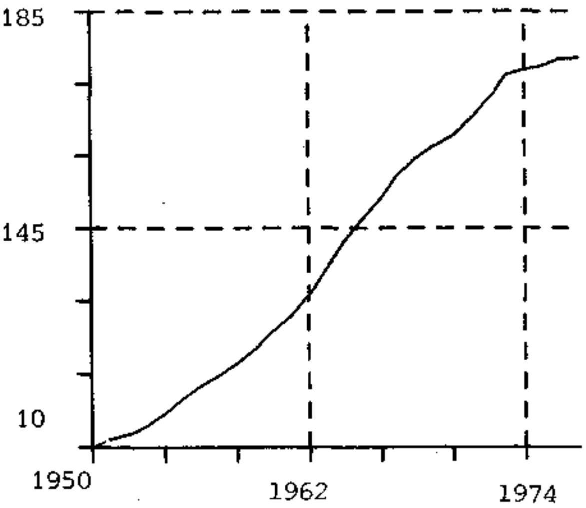
a. Mexico



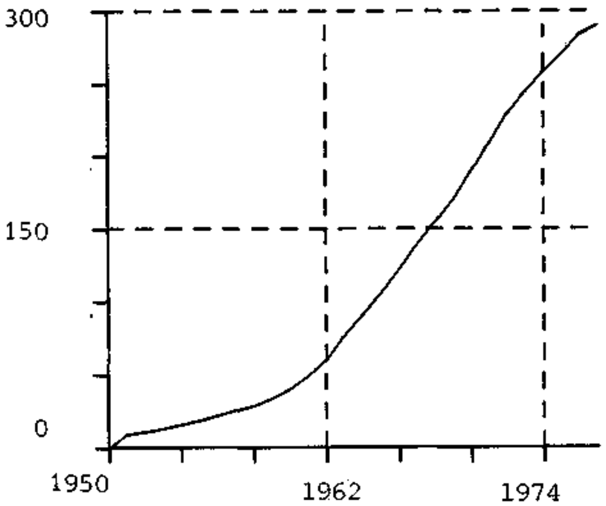
b. Netherlands



c. USA



d. United Kingdom



e. Italy

<u>Figure 3.3</u> Passenger cars in use per 1000 persons

Table 3.1 Development in car ownership

	level	transition 1→2		transition 2→3		change	change
	1951 (1)	year(s) (2)	level (3)	year(s) (4)	level (5)	1974 (6)	1974-1977 (7)
Argentina	19	'61-'63?	30?	>'77		0.63	1.16
Australia	105	<'51		>'77		1.33	0.98
Austria	9	'60-'62	50	>'77		1.01	1.16
Belgium + Luxemburg	35	'63-'66	130	>'77		1.00	0.98
Brazil	5	'68-'70?	25?	>'77		0.53	0.85
Canada	150	<'51		>'77		1.86	1.23
Denmark	28	'60-'61	100	'70-'71?	225?	-0.23	0.71
Finland	9	'64-'66	100	>'77		0.69	0.73
France*	38	'63	160	'63	160	0.77	1.00
Greece	1	>'77		>'77		0.82	2.06
Ireland	35	'59-'60	60	>'77		0.53	1.09
Italy	9	'62-'64	70	'73	240	0.75	0.59
Japan	81	'69-'70	80	>'77		0.52	0.60
Mexico	8	?		?		1.84	1.23
Netherlands	15	'63-'64	80	>'77		0.86	0.90
New Zealand	135	<'51		>'77		1.82	0.38
Norway	21	'61-'62	80	>'77		1.39	1.94
Portugal	8	'69-'71	70	>'77		1.16	0.83
Spain	3	'72-'74	110	>'77		1.13	1.11
Sweden	44	'52-'54	50	'64-'66	230	1.37	0.80
Switzerland	36	'59-'62	100	>'77		0.83	0.92
United Kingdom	50	'63-'67	170	'63-'67	170	0.28	0.23
United States	276	<'51		>'77		0.74	0.73
Germany, Fed. Rep.	16	'59-'61	80	>'77		0.25	1.09
Yugoslavia	0	'69-'70	30	>'77		1.33	1.31

Note:

(1): number of cars per 1000 persons in 1951

(2) and (3): year(s) and approximate level of car ownership (cf. (1)) for transition from phase 1 to phase 2.

(4) and (5): ditto for transition from phase 2 to phase 3.

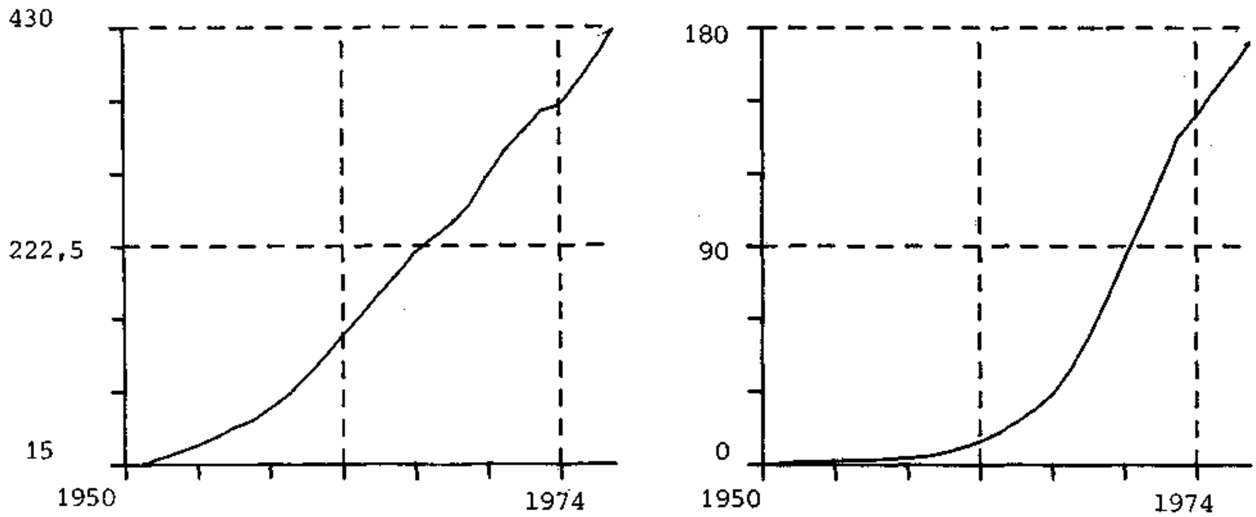
(6): increase in degree of car ownership in 1974 compared to the average of 1968-1973.

(7): ditto for average 1974-1977 compared to average 1968-1973

* : thusfar, France is the only country where phase 2 seems to be absent.

While discussing the graph for the United Kingdom (cf. figure 3.3d) it was suggested that the oil crisis in 1973-1974 might have affected car ownership from 1974 onward. Some countries do not show any significant direct effect e.g. Mexico (cf. figure 3.3a), Netherlands (cf. figure 3.3b). In some case, e.g. Italy (cf. figure 3.3e), it is not clear whether the shape of the graph is "normal" or affected by the oil crisis (cf. figure 3.3c for the United States). Quite a few countries were affected significantly, either for 1 year only (cf. Germany, figure 3.4a) or for all years since 1974 (cf. Japan, figure 3.4b).

Figure 3.4 Passenger cars in use per 1000 persons.



a. Germany

b. Japan

Some statistics on this phenomenon are put together in the last two columns of table 3.1

(Z_t = number of cars per 1000 persons)

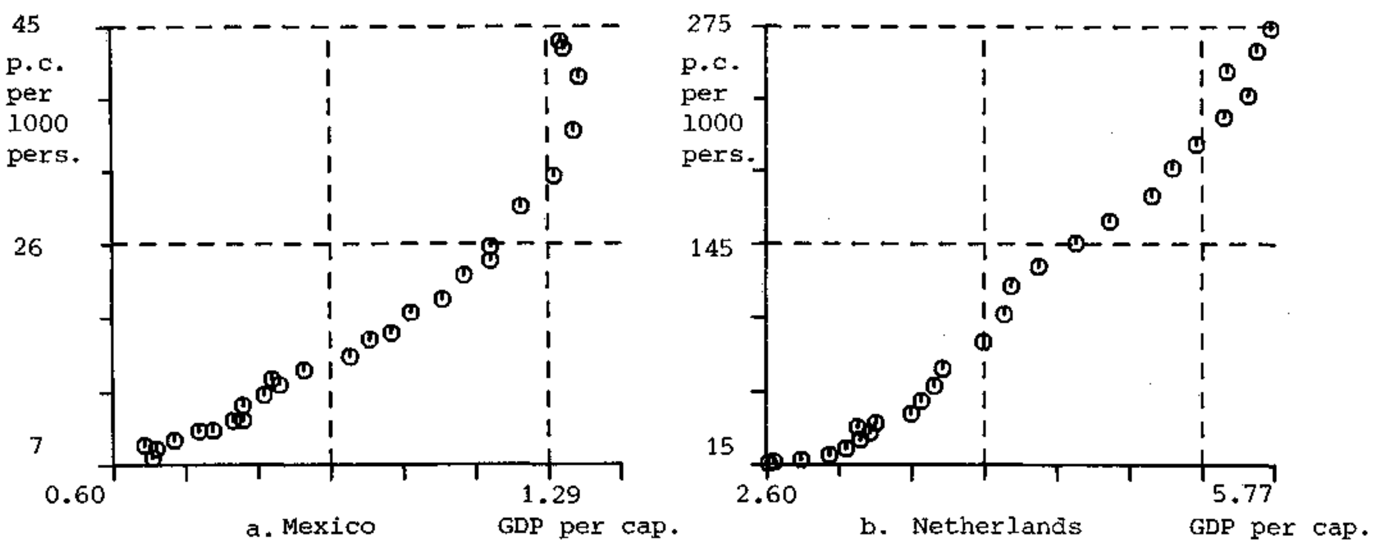
- a change in direction in 1974: $\dfrac{Z_{1974} - Z_{1973}}{(Z_{1973} - Z_{1968})/5}$

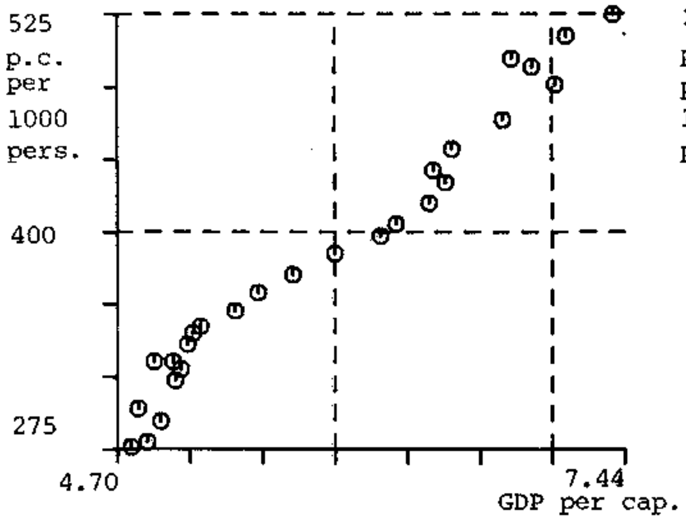
- a change in direction from 1974 onwards: $\dfrac{(Z_{1977} - Z_{1974})/3}{(Z_{1973} - Z_{1968})/5}$

It is clear that the number of cars in many countries was not affected significantly.

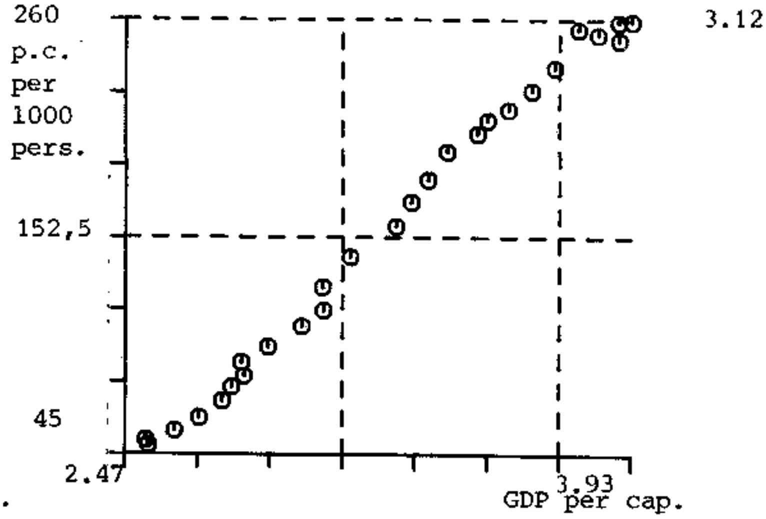
Many authors introduce per capita income as the main (or only) determinant for car ownership. To check the validity of this assumption, below we show scatter diagrams for the countries for which we have shown the graphs for cars per 1000 inhabitants (figure 3.5).

Figure 3.5 Scatter diagram passenger cars per 1000 persons (p.c. per 1000 pers.) and GDP per capita in 1975 in U.S. $ (x 1000) (GDP per cap.).

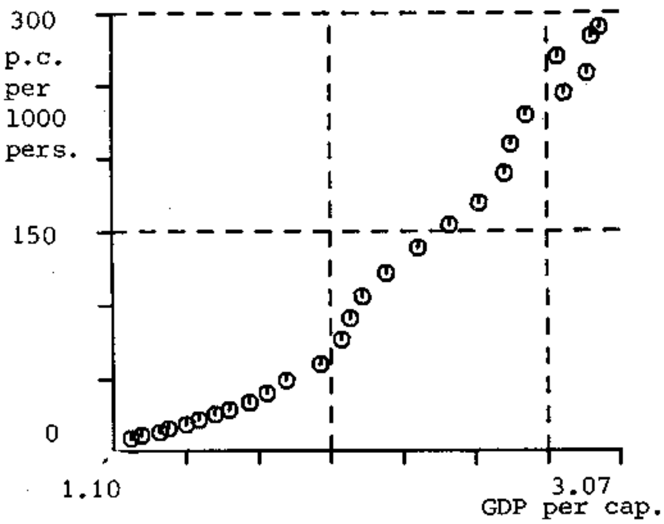




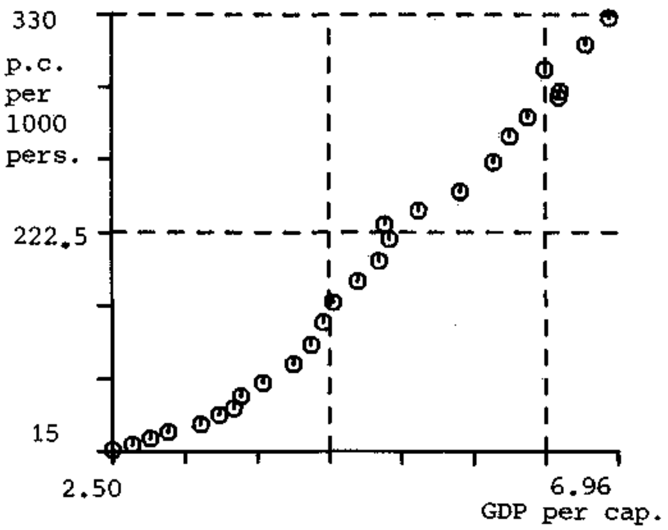
c. USA



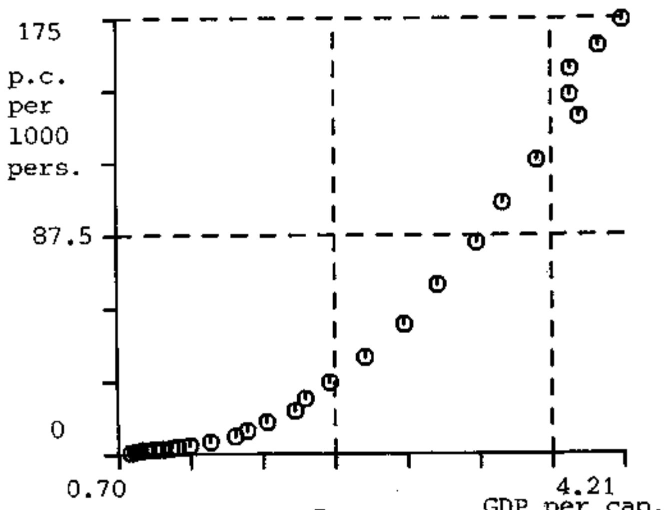
d. United Kingdom



e. Italy



f. Germany, F.R.



g. Japan

Figure 3.5 (Continued)

The main conclusions to be drawn are:

- the relationship is not linear over a long period of time;
- the graphs of car ownership over time (figures 3.3 and 3.4) are smoother than the scatter diagrams with GDP per capita, indicating the variations in GDP per capita hardly affect car ownership;
- reduction in GDP per capita in or since 1974 has hardly had any effects on car ownership; although this may be explained from a possibly larger decrease in profit income than in personal income, still there may be other reasons: there may be an autonomous movement in car ownership or the relationship between car ownership and GDP may be irreversible;
- no significant levelling off tendency can be observed if car ownership is related to GDP per capita.

Before deciding on the relationship between car ownership and the variables affecting it (section 3.5) some remarks have to be made about possible saturation levels.

3.4 Determination of saturation levels

In previous sections it was concluded that a possible saturation level may play a very important role in long run projections of car ownership. Although historical developments in the sixties and seventies show rather linear functions for the relationships between car ownership and time and income per capita, it is intuitively clear that this cannot continue and that some kind of levelling off must be envisaged, due to other influences than those included in the specification.

Determination of saturation levels from time series data was concluded to be extremely dangerous and irrealistic if not bluntly impossible. Therefore a methodology had to be developed in order to arrive at a saturation level for each country. It is clear that the assumption of differences in saturation levels between countries cannot be omitted, because of differences in demographic and geographic characteristics.

Some demographic factors on which data can be obtained and which are relevant to car ownership are discussed first. A very important factor is the number of people basically able to drive a car. This may be indicated by the percentage of people of age 19 and older. Data for countries with a reasonably high rate of car ownership[1)] in 1975 show a range from 59.9 % for New Zealand to 72.5 % for Sweden. Assuming a maximum of 1 car per person, reducing this with a few percentages points for people who will never drive a car and adding a few for such cars as business cars and taxis, we may derive proxies for

1) Australia, Austria, Belgium and Luxemburg, Canada, Denmark, Finland, France, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States and West-Germany are the countries included in the analysis.

"absolute saturation levels" per 1000 persons of about 625 for New Zealand and 750 for Sweden at this juncture.

Owing to change in population composition, these absolute saturation levels may change over time. An indicator which may be used for similar purposes is average household size. Population composition and household size are strongly correlated in a cross-section for 1975[1] (r = -.79). However, average household size may also include some other aspects related to car ownership, such as the social role of the family. Data on houshold size in 1975 shows rather high figures for Ireland, Spain, Portugal, Iceland, Netherlands, Japan and New Zealand, ranging from 3.8 down to 3.3. The lowest figure is 2.5 for Sweden.

A socio-demographic phenomenon, which might put pressure on car ownership is demand for cars by women working outside the household. An indicator for this may be female participation rate. This variable ranges from around 19 % for Spain and Italy to above 40 % for Denmark, Sweden and Finland in 1975.

Next to demographic there are geographic factors, possibly influencing the saturation level,such as population density (highest for the Netherlands (366 per square kilometer) and lowest for Australia (1)). On the one hand this will affect availability of land for road-construction, on the other hand availability of public transport will be much better. Both factors may have a depressing influence on the saturation level. Availability of land for living and road construction may be reduced by mountaineous areas, lakes, deserts etc. Thus, the percentage of inhabitable area will have to be included. This percentage is very low for Finland (23.5 %), Japan and Sweden (32.5 %) and very high for Ireland (94.9 %) and the United Kingdom (90.5 %).
Correcting population density for the percentage of inhabitable area,an extremely high figure for Japan (920) is obtained, followed by Belgium and Luxembourg (412), the Netherlands (401) and West-Germany (359). Australia still has the lowest figure: 2 persons per square kilometer of inhabitable area.

It is not only population density but also concentration of people in a small area which may reduce possible long term increase in car ownership. Thus, urbanization may play an important role. Urbanization in general does not necessarily reduce car ownership levels. Besides, owing to differences in definition,

---

1) See note page 30.

no data which are comparable between countries are available. Therefore it is better to use as an indicator the percentage of urban population in cities of over 500,000 people, being very high for the USA (75 %) and Australia (68 %) and rather low for Sweden, Switzerland, Belgium, Netherlands and Finland (from 22 % to 27 %) in 1975.

Finally, turning to factors more directly related to cars, one may suggest tax incidence on cars and their usage. Using various types of taxes, bearing on car ownership and use[1), an indicator is arrived at, which shows very low figures for New Zealand, Canada, USA, Australia, Portugal and Spain, whereas very high tax levels were found for such countries as Iceland, Finland, Norway, Switzerland and Ireland.

The last factor,called in as a variable possibly explanatory to car ownership in a country is car production, which may reflect the role the passenger car is playing in a country and the level of acceptance it is enjoying.

In order to estimate the saturation level for various countries we start from the observation that it has nowhere been reached as yet. The main reason for this is insufficient income per capita. Thus, we may formulate the following models, using a log linear specification, which is more appropriate in case of cross-sections

$$\frac{Z_i}{S_i} = \alpha_0 \, Y_i^{\alpha_1} \, e^{u_i} \text{ with } \frac{Z_i}{S_i} \leq 1$$

where i = country number

Z_i = passenger cars in use per 1000 persons

S_i = saturation level, expressed in number of cars per 1000 persons

Y_i = income per capita

u_i = disturbance term.

Basically, this is a simplified and restricted version of the relationships which will be specified in section 3.5.1.

Having postulated a model for Z_i/S_i, we may now formulate an equation for S_i.

$$S_i = \beta_0 \prod_{j=1}^{J} X_{ji}^{\beta_j} = \beta_o \, X_{1i}^{\beta_1} . X_{2i}^{\beta_2} \; .... \; X_{Ji}^{\beta_J} \tag{3.5}$$

where X_{ji} are variables explaining the saturation level in country i.

---

1) taxes on acquisition (import, purchase, registration), taxes on ownership, driving license fees and taxes on use (fuel, tires, road taxes); Source: World Road Statistics by the International Road Federation, Geneva, Washington.

They have been discussed above and may be listed as follows:

- percentage of people of 19 years and older (X_{1i})
- household size (X_{2i})
- female participation rate (X_{3i})
- population density (X_{4i})
- percentage of inhabitable area (X_{5i})
- population density corrected for percentage inhabitable area (X_{6i})
- urbanization (X_{7i})
- taxes bearing on car ownership and use (X_{8i})
- production of passenger cars (X_{9i})

The constraint $\frac{Z_i}{S_i} \leq 1$ can be met for each country by moving β_o.

Of course, only a part of these variables may be included in (3.5).
Since we have no data on S_i, we substitute (3.5) into (3.4) :

$$Z_i = (\alpha_0 \ \beta_0) \ Y_i^{\alpha_1} \prod_{j=1}^{J} X_{ji}^{\beta_j} \ e^{u_i} \tag{3.6}$$

Estimation gives estimated values $(\widehat{\alpha_0.\beta_0})$, $\hat{\alpha}_1$, $\hat{\alpha}_2$, $\hat{\beta}_j$ $(j = 1, ..., J)$.

Now S_i can be derived except for a constant factor because $(\widehat{\alpha_0 \ \beta_0})$ cannot be split into $\hat{\alpha}_0$ and $\hat{\beta}_0$. This means that this result can be used to fix the ratios of the S_i. An exogenously given saturation level S_k for country k, determines the saturation levels for the other countries, because now β_0 can be derived.

Estimation results showed that it was not possible to include population structure (X_1), female participation rate (X_3) and population density corrected for percentage inhabitable area (X_6).Three base levels for saturation in the USA have been used. They are arrived at using population composition (about 68 % are potential car drivers) and current levels of car ownership (about 530 per 1000 persons). Results are given in table 3.2. Rounded saturation levels, to be used in the analysis can be found in table 3.3.

Table 3.2 Estimation of saturation levels

	ratio saturation levels	S-USA = 600		S-USA = 650		S-USA = 700	
		satur. level	ratio act.	satur. level	ratio act.	satur. level	ratio act.
USA	1.000	600	0.83	650	0.77	700	0.71
Canada	1.010	606	0.65	657	0.60	707	0.55
Japan	0.537	322	0.48	349	0.44	376	0.41
Australia	1.040	624	0.58	676	0.54	728	0.50
New Zealand	1.080	648	0.58	702	0.54	756	0.50
W. Germany	0.790	474	0.61	514	0.56	553	0.52
France	0.798	479	0.61	519	0.56	558	0.52
United Kingdom	0.804	483	0.53	523	0.49	563	0.45
Netherlands	0.575	345	0.72	374	0.66	403	0.62
Belgium + Lux.	0.656	393	0.68	426	0.63	459	0.58
Denmark	0.717	430	0.59	466	0.55	502	0.51
Iceland	0.962	577	0.50	625	0.46	673	0.43
Sweden	0.716	430	0.78	466	0.72	501	0.72
Switzerland	0.720	401	0.70	435	0.67	468	0.67
Ireland	0.652	391	0.42	424	0.39	457	0.36
Norway	0.774	465	0.51	503	0.47	542	0.44
Finland	0.535	321	0.66	348	0.61	374	0.57
Austria	0.722	433	0.53	469	0.49	506	0.45
Italy	0.733	440	0.61	477	0.57	513	0.53
Spain	0.666	399	0.34	433	0.31	466	0.29
Portugal	0.649	390	0.29	422	0.27	454	0.25

Note: 1st column: estimated ratio of saturation level per country over saturation level of the USA.

2nd, 4th, 6th column: estimated saturation level per country.

3rd, 5th, 7th column: ratio of actual level of car ownership over estimated saturation level.

Table 3.3 Saturation levels for three scenarios, expressed in passenger cars per 1000 persons

	Saturation levels		
	Scenario S1	Scenario S2	Scenario S3
USA	600	650	700
Canada	610	660	710
Japan	320	350	380
Australia	620	680	730
New Zealand	620	680	730
W. Germany	470	510	550
France	480	520	560
United Kingdom	480	520	560
Netherlands	350	370	400
Belgium + Lux.	390	430	460
Denmark	430	470	500
Iceland	580	630	670
Sweden	430	470	500
Switzerland	400	440	470
Ireland	390	420	460
Norway	470	500	540
Finland	320	350	370
Austria	430	470	510
Italy	440	480	510
Spain	400	430	470
Portugal	390	420	450

3.5 Developments in car ownership

In the previous sections we have arrived at a series of conclusions concerning past and perspective developments in car ownership. They may be briefly reviewed as follows:

- there has been, is or will be a diffusion process, a learning process;
- this diffusion process is rather autonomous over time if income permits;
- more attractiveness of cars because of changes in relative prices, supply, quality, etc. is indistinguishable from diffusion aspects;
- the diffusion aspect of growth in car ownership may very well follow a logistic or cumulative normal distribution function of time;
- there will be a saturation level; scenarios for the saturation level have been drawn up in 3.4;
- it is better for our purpose to use cars in use per 1000 persons than per household or family;
- at a later stage growth in car ownership will be more income dependent.

In view of this it is clear that a different approach is needed for:

- countries with a relatively high level of cars per 1000 persons;

- countries with relatively low levels of car ownership;

The first group is roughly the same group of countries which have been used in the analysis for the saturation level in 3.4. It consists of the countries where the level of car ownership is at least 125 per 1000 persons in 1975 (thus excluding Portugal). Relatively small countries such as Malta (= other West Europe), Iceland, Kuwait and Lybian Arab Jamahiriya have been included in the second group.

3.5.1 Car ownership in larger countries with high car density

Above it was concluded that for any country in this group the number of cars per 1000 persons (Z_t) is in one way or another related to income per capita (Y_t), autonomous movements, such as diffusion, represented by time (t) and a saturation level S.

$$Z_t = f\ (Y_t,\ t,\ S) \qquad (3.7)$$

This function should follow the path of the logistic function, the cumulative normal distribution function or the cumulative lognormal distribution function. As it is very hard to distinguish between these functions, on the basis of available data, we have chosen the logistic function because it is easier too handle.

A possible specification is

$$Z_t = \frac{S}{1 + \alpha_1 e^{-\alpha_2 Y_t - \alpha_3 t}} \tag{3.8}$$

There are at least two objections against (3.8): During most of the sample period income per capita is strongly linearly correlated with time. Therefore multicollinearity creates a lot of estimation problems and a simple logistic function of time might serve as well. However, because of its shape (cf.figure 3.2), the simple logistic function needs to be abolished in case of car ownership. Secondly, Y_t and t must have their major impact at different points in time. This can only be realized if two separate logistic functions for income and time act as explanatory components

$$Z_t = \frac{S^Y}{1+\alpha_1 e^{-\alpha_2 Y_t}} + \frac{S^t}{1+\alpha_1 e^{-\alpha_4 t}} \tag{3.9}$$

under the constraint that $S = S^Y + S^t$. This may be written as $S^Y = \gamma S$ and $S^t = (1-\gamma)S$.

Equation(3.9) contains five parameters to be estimated α_1, α_2, α_3, α_4 and γ. This is just a bit too much for a non-linear estimation method. It is made even more complicated because of the specification of the function and the strong correlation between Y_t and t.

The first step for improvement is the inclusion of some assumptions about S, S^Y and S^t. This boils down to the following questions:

- which saturation level must be applied to past data: S_1, S_2 or S_3 according to the scenarios of table 3.3 or perhaps another S?
- with which saturation level must γ be combined and what must be the level of γ?

Our analysis leads us to the following conclusions:

In the past levels of car ownership were rather low compared to any reasonable saturation level. Changing the saturation level from year to year while applying (3.9) will not be very relevant. Besides the part $(1-\gamma)$of the total saturation level to be attributed to S^t should not be too big. On the other hand, future scenarios for S_1, S_2 or S_3 should not affect S^t because the diffusion process has almost been completed in some countries and because higher saturation levels than S_1 can only be realistic if income allows for these developments.

Finally, the overall estimation results are not affected dramatically if S_t is related to S_2 or S_3 rather than to S_1 and estimation results are rather robust with respect to $S^t = 0.4\ S_1$, $S^t = 0.5\ S_1$ or $S^t = 0.6\ S_1$.

Taking all above considerations into account we use the following approach for the estimation part

$$S^t = 0.5\ S_1 \qquad (3.10)$$

$$S_1^Y = S_1 - S^t$$

and for projection purposes

$$S^t = 0.5\ S_1 \qquad (3.11)$$

$$S_k^Y = S_k - S^t \text{ for } k = 1,\ 2,\ 3$$

As an alternative to equation 3.9 we have used a five year moving average of Y_t instead of Y_t to eliminate short term flunctuations in income which do not immediately affect Z_t. In general this gave slightly better results. Correlation coefficients (R^2) were ranging from 0.989 for USA and 0.993 for Switzerland to 0.999 for Belgium and Luxemburg, Finland and Austria and 1.000 for Japan, Denmark, Italy and Spain.

3.5.2 Car ownership in other countries

The countries described in the previous sub-section represented 85 % of world car park in 1977. The remaining 15 % was distributed as follows

Other America	5.5 %
Other Asia, Africa + Oceania	4.0 %
Other Europe	5.5 %.

It is impossible to do a similar elaborated analysis for several reasons:
- quality of the data;
- length of time series;
- less systematic development.

Besides, the contribution of the countries, focussed upon in this sub-section, does not require as detailed an analysis as the countries studies in the previous sub-section.

Many types of equations have been used to analyze developments in the number of cars use per 1000 persons over time. We shall refrain from giving details on all estimation results and confine ourself to indicating which equation specification proved to be useful. The following specifications were applicable in at least one case

$$Z_t = \alpha_1 + \alpha_2 Y_t \tag{3.12a}$$

$$Z_t = \alpha_1 + \alpha_2 t + \alpha_3 Y_t \tag{3.12b}$$

$$\ln Z_t = \alpha_1 + \alpha_2 \ln Y_t \tag{3.12c}$$

$$\ln Z_t = \alpha_1 + \alpha_2 t + \alpha_3 \ln Y_t \tag{3.12d}$$

$$Z_t = \alpha_1 - \alpha_2 e^{-\alpha_3 Y_t} \tag{3.12e}$$

where again Z_t = cars in use per 1000 persons

Y_t = income per capita.

Table 3.4 gives a list of (groups of) countries and the specifications which looked useful for each country or group of countries. China and the other Asian Centrally Planned Economy Countries must be treated separately, because the current situation is not yet covered by sufficient data.

Table 3.4 Specification chosen for the relation between cars per 1000 persons and income per capita

number	country (group)	specification [1)]
12	Iceland	e
21	Portugal	b
22	Greece	c
23	Turkey	c
24	Yugoslavia	b
25	Other W. Europe	e
26-32	USSR + E. Europe	a
33	Brazil	b
34	Argentina	b
35	Mexico	c
36	Other Latin America	c
39	India	b
40-43	Other S. Asia	a
44	Indonesia	d
45	Malaysia	d
46	Philippines	d
47	Thailand	d
48	Singapore	e
49	Hong Kong	e
50-52	Korea etc.	d
53-54	Oil prod.ME + NA	c
55	Other ME + NA	b
56-58	Other Africa	b

1) Specification code a, b, c, d, e refer to equations 3.12a, b, c, d, e respectively.

3.5.3 Projections of passenger cars in use

In chapter 2 scenarios G1, G2 and G3 for GDP have been detailed and in section 3.4 scenarios for saturation levels S1, S2 and S3 were described. Together with one scenario for population projections, the basis has been laid for projections of passenger cars in use. The energy aspect however - E-scenarios - still has to be fitted in. The three GDP growth scenarios have already taken energy aspects into account, in the sense that E1 does not allow for more growth than G1, or possibly G2, whilst E2 would allow for higher growth rates, i.e. G2 or G3. The energy situation may also affect the saturation level.

The main elements of the passenger car market, which are influenced by the energy situation are

- car ownership, and
- driving distance which possibly affects car life.

The common opinion is that to reduce (growth in) car ownership, energy availability should become extremely limited. Most people will keep their (aspirations for having a) car but drive less. Driving distance is element of chapter 5 and car life is discussed in section 3.6. Besides, in some countries some people may switch to smaller cars.

The scenarios for GDP growth and saturation level can now be combined via assumptions about the E-scenarios. Although in theory, with G-, E- and S-scenarios 3 x 2 x 3 = 18 combinations all feasible, their interrelationship makes some of these combinations practically impossible, as is shown in table 3.5.

Table 3.5 Relationship between G-, E- and S-scenarios.

scenario for		saturation levels S1	S2	S3
growth	G1	E1	-	-
in	G2	E1	E2	-
GDP	G3	-	E2	E2

or

scenario	combination of		
a	G1	E1	S1
b	G2	E1	S1
c	G2	E2	S2
d	G3	E2	S2
e	G3	E2	S3

The first combination: G1, E1 and S1 is called the standard scenario. Projections for passenger cars per 1000 persons are presented in table A.12 and summarized in table 3.6. The other 4 combinations are only presented by broad regions in table A.13. Similarly projections for total cars in use are presented in tables A.14, 3.7 and A.15.

It can be concluded from these tables that many developed countries, in particular Japan, are approaching the saturation levels. This implies a high sensitivity to the choice of the scenario for the saturation level. As can be seen from the standard scenario, scenario a for the USA,growth in GDP should be sufficient to come close to the saturation level.

The effects of different GDP scenarios are very pronounced in these cases where saturation levels are not(yet) about to be reached or where saturation levels are not yet relevant e.g. East Europe, Latin America and the Middle East.

Table 3.6 Projections of passenger cars per 1.000 persons, standard scenario.

		1985	1990	1995	2000
I.	North America	537.1	545.4	562.2	572.5
II.	Asia, developed	246.1	294.3	315.7	319.5
III.	Oceania, developed	446.4	501.8	553.4	584.9
IV.	North-West Europe	350.5	370.1	382.1	389.9
V.	South-West Europe	181.5	195.0	205.3	211.0
VI.	Eastern Europe	37.6	45.4	55.1	65.0
VII.	Latin America + Caribbean	49.9	58.6	71.1	85.2
IX.	South Asia	2.3	2.8	3.4	4.1
X.	South-East + East Asia	12.8	18.1	26.4	38.7
XI.	Middle East + North Africa	36.0	39.0	42.9	46.6
XII.	Other Africa	13.2	14.7	16.2	17.6

Table 3.7 Projections of passenger cars in use, standard scenario. (in thousands)

		1985	1990	1995	2000
I.	North America	138,388.8	146,376.5	155,649.1	162,784.3
II.	Asia, developed	29,708.5	36,252.7	39,537.4	40,645.7
III.	Oceania, developed	8,254.5	9,612.3	10,894.9	11,776.0
IV.	North-West Europe	82,466.4	87,521.8	90,701.0	92,697.7
V.	South-West Europe	35,084.9	39,927.3	44,361.6	47,841.5
VI.	Eastern Europe	14,825.8	18,581.9	23,234.2	28,221.6
VII.	Latin America + Caribbean	20,778.4	27,951.9	38,380.4	51,786.6
IX.	South Asia	2,252.9	3,050.8	4,074.0	5,263.7
X.	South-East + East Asia	4,721.3	7,402.7	11,772.5	18,614.7
XI.	Middle-East + North Africa	6,121.5	7,539.2	9,316.4	11,251.0
XII.	Other Africa	5,668.3	7,341.4	9,439.0	11,961.9
	World, excl. Asian Centrally Planned Economies	348,271.1	391,558.3	437,360.5	482,844.7

3.6 Discards and new registrationsof passenger cars

3.6.1 Introduction

Discards or replacements occur in many models on consumer behaviour. Probably the most simple approach is to assume that replacement is a fixed percentage of existing stock of durable consumer goods or in our case, passenger cars. This is the method used e.g. by Chow (1957). In Chow's study it has been mixed with the method of counting an old car only partially in determining total stock. Some refinement has been introduced by Stone and Rowe (1957, 1958).They have assumed replacement to equal a certain percentage of the opening stock of a period plus an equal or smaller proportion of purchases during that period.
This approach, also applied by O'Herlihy (1965), may be called the method of reducing (or radio-active) depreciation. Basically, replacement is related to past sales where depreciation of an n year old car with a depreciation rate of d equals $(1-d)^n$. This resembles a distributed lag scheme with geometrically declining weights. As has been pointed out by Smith (1975), this type of dynamic model tends to show a very high depreciation. This is borne out by such studies as done by Chow (1957), Williams (1971) and O'Herlihy (1965). Besides,this kind of model cannot allow for waves of replacement generated by fluctuations in purchase.

Alternatively, one may use the scrapping or "sudden death" approach. A very simple example is the method used by Brems (1956), where scrapping in year t equals purchases in year t-L (L = average life of a car). A refinement is to provide a distribution in the lag and to apply distributed lags and/or mortality curves. Some of the studies along these lines will be mentioned first.

One of the first studies, back in the 1930s, is the study by De Wolff (1938). The analysis has been based on data about percentages of cars still in use after n years. Thus, the expected number of discarded cars has been calculated. The difference between actual and calculated scrappage has been explained using business cycle indicators e.g. non workers' income. It is interesting to note that average life (pre-war) has been estimated at about 7.5 years. Application of mortality tables to scrappage of cars for the USA has also been done by Walker (1968). A mortality curve on the basis of the mortality table closely resembles a logistic curve. Parameters of the logistic curve fitting to mortality data have been estimated and theoretical scrappage has been calculated.

Discrepancies between actual and theoretical scrappage has been explained from new registration, relative car prices and total stock. The latter part may not be too obvious. In a study on several car types, makes and model in the USA, Wykoff (1970) has concluded that a constant rate of depreciation with age for automobiles is not appropriate; this may support replacing an exponential curve perhaps by a logistic curve. He argues, however, that some doubts exist about the assumption of no shifts in the mortality curve for different vintages of cars. New cars may last longer or shorter, owing to technological improvements, changes in driving habits and distance, safety regulations etc. However, in a study comparing many countries, Jacobsson (1973) has concluded to the absence of changes in scrapping profiles over time.

Some refinements about replacement behaviour in the USA have been introduced by Smith (1975). For the USA, it has been calculated that only 0.7 % of new car buyers scrapped the car they replaced. Besides, the group of new car buyers does not vary very much, both in size and composition. It can therefore be concluded that the elasticity of substitution between the new and used car markets is not very high. However, it is beyond the scope of this study to include the used car market into the model. We expect not to introduce too big an error, particularly because the timing of replacement by new car buyers will be affected by price differentials between new car price and trade in or selling price of the car to be replaced.The elasticity of substitution may be a bit low,but the effect of low second hand car prices (induced by recession etc.) may be a lengthening of car life in general and postponing of new car replacement in particular, thus reducing new car sales.

3.6.2 Modeling new registrations and discards of passenger cars

For the purpose of this study,it is clear that an approach following the lines of a mortality table looks most promising. Unfortunately, accurate mortality tables are available for a few countries only. And in those cases one often encounters data on vehicles in use by model year rather than by year of registration. As many cars of a certain model year are sold and registered in the following year or even one year later (possibly up to 30-40 %), usage of these kinds of tables introduces considerable inaccuracies.

Basically the model to be used is (cf. section 2.1)

$$G_t = \Delta Z_t^T + H_t \tag{3.13}$$

$$H_t = f\ (G_{t-k}),\ k = 0,1,2,\ldots k^{max} \tag{3.14}$$

where G_t = new registrations

k = lag between new registration and scrappage

Z_t^T = total registrations = total number of cars in use

ΔZ_t^T = change in total registrations

H_t = discards = deregistration.

Total registrations can be derived by multiplying passenger cars in use per 1000 persons (section 3.5) and population (in thousands). In this section, we focus on discards H_t and thus on equation (3.14). Afterwards, new registrations G_t may be calculated using (3.13).

The most important reason for a car to be discarded is its age. However, life of a car will be different for each car. Using United States time series data on vehicles constructed in a particular year, and calculating the share of these vehicles still in use after k years, the pattern roughly is as plotted in figure 3.6. This means that during some years (where k is small) the share hardly decreases. Over time the share decreases more and more rapidly, so that the probability of a particular vehicle being discarded increases more and more until the point of inflexion (in figure 3.6) reached at age k^*. After this point the rate of decrease in share declines so that the probability of discarding declines also. The probability curve for this time series is shown in figure 3.7.

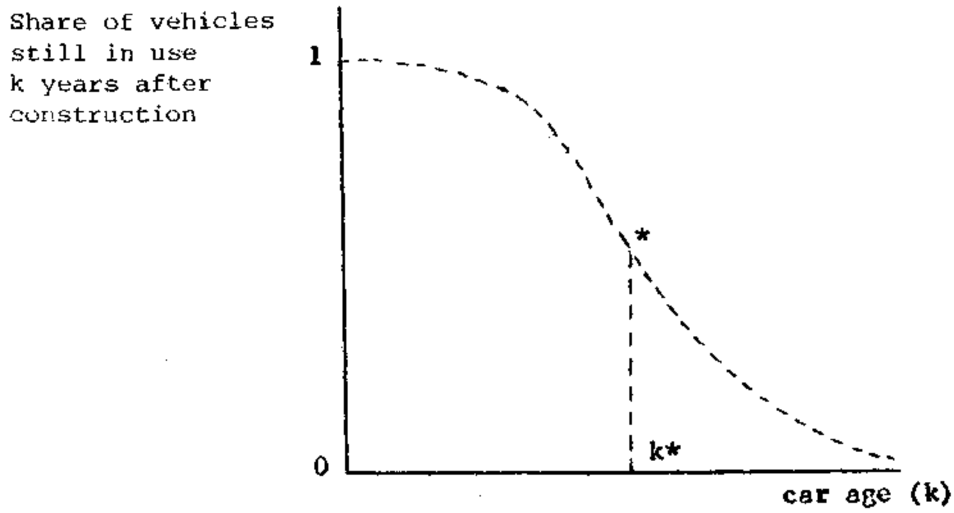


Figure 3.6 Mortality curve for passenger cars

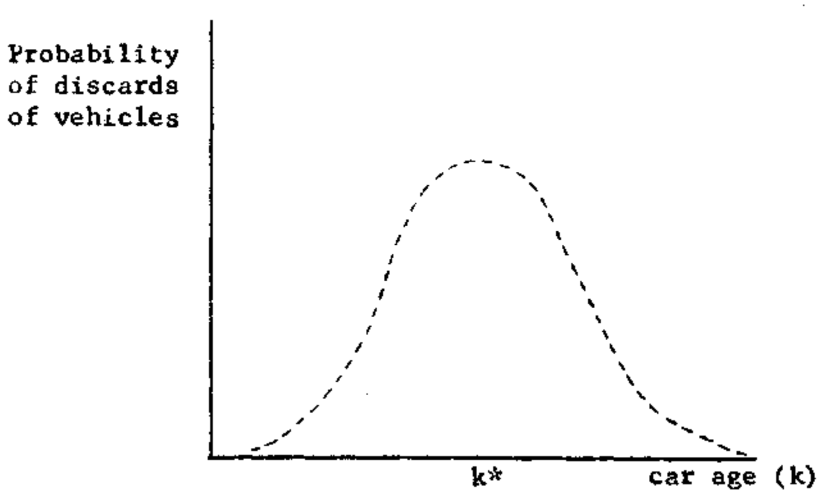


Figure 3.7 Probability distribution of figure 3.6

A way of dealing with the problem of obtaining coefficients β_k following the shape of the lag distribution, is to assume that the lag coefficients follow the pattern of probability density functions. We have selected three types with mean μ and standard-deviation σ.

a. Poisson distribution:

$$\beta_k \ (\lambda) = \frac{e^{-\lambda}\lambda^k}{k!} \tag{3.15}$$

where $\mu = \lambda$ and $\sigma = \lambda$

b. Logistic distribution

$$F(A,B) = \frac{1}{1 + e^{-(k-A)/B}} \tag{3.16}$$

where $\mu = A$ and $= \frac{B\ \pi}{V3}$

$$\text{so } \beta_k \ (A,B) = \frac{e^{-(k-A)/B}}{B(1+e^{-(k-A)/B})^2} \tag{3.17}$$

c. Normal distribution

$$\beta_k(\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(k-\mu)^2}{2\sigma^2}} \tag{3.18}$$

Now criteria have to be established to choose among probability distributions and to estimate μ and σ. Generally speaking, expected discarding $\hat{H}_t$ should give a good fit to actual discarding H_t. This can be quantified in two ways:

1. Minimize $c_1 = \Sigma\ (H_t - \hat{H}_t)^2$

   where $\bar{H}$ is the mean of H_t.

2. Minimize $c_2 = \Sigma(^{H}t/_{\hat{H}_t} - 1)^2$

This latter criterion is based on the assumption that the ratios of H_t and $\hat{H}_t$ should roughly equal 1.

It is realistic to assume that suitable aggregation of similar countries hardly affects the results of the analysis, because scrapping behaviour will be rather similar. Doing the analysis for these groups of countries, if data permit, optimal specifications and values of parameters may be specified. Of course, the most interesting part is average life of passenger cars. Results are shown below in table 3.8. For many countries, lack of data or estimation results forced us to derive information about average life with less advanced methods. Some countries or regions might be assigned slightly different values in view of recent information. This will be taken care of below in scenario D2. Differences between some countries, e.g. France and Italy, appear to be a bit too big.

Table 3.8 Average life of passenger cars

Country or group of countries		Average life of passenger cars in years
1.	United States	11.4
2.	Canada	12.6
3.	Japan	8.0
4-5.	Australia + New Zealand*	12.6
6.	Germany F.R.	10.2
7.	France	10.8
8.	United Kingdom	10.6
9-14.	N.W. Europe	9.8
15-18.	N.W. Europe*	10.8
19.	Italy	13.0
20-25.	S. Europe	13.6
26-32.	E. Europe*	13.0
33-36.	Latin America*	14.0
39-43.	S. Asia*	15.0
44-52.	E. + S.E. Asia*	14.0
53-54.	Middle East + N. Africa (oil)*	12.0
55-58.	Other M.E. + Africa*	14.0

* data or estimation results did not permit estimation in an advanced way.

3.6.3 Projections of discards and new registrations of passenger cars

The above estimates can be used for projections of discards and new registrations of passenger cars for countries and regions of the world. At the same time they have to be assessed and prospects for average life have to be determined. Some factors to be taken into consideration are:

- increased safety regulations might reduce average vehicle life;
- vehicle quality might improve, increasing average age;
- reduced driving speed for reasons of energy saving and safety, might increase average age;
- vehicle density with respect to population size and income, reducing driving distance may result in longer vehicle life;
- worsening energy situation may also reduce driving distance and thus increase vehicle life;
- low levels of economic growth may also lead to increased vehicle life.

It may be concluded that at present most changes seem to lead to a perspective increase in vehicle life because of limited availability of energy and lower economic growth. Quantification of this perspective however is pretty difficult. We shall use, for projection purposes, two scenarios

- standard scenario D1: no change in average life
- scenario D2: small increase in vehicle life with 0.1 year per year for countries 1-25 only after adjusting average life in view of recent developments in scrapping behaviour.

This leads the way to the following scenarios for discards and new registrations

a1 : G1 + E1 + S1 + D1	and	a2 : G1 + E1 + S1 + D2
b1 : G2 + E1 + S1 + D1		b2 : G2 + E1 + S1 + D2
c1 : G2 + E2 + S2 + D1		c2 : G2 + E2 + S2 + D2
d1 : G3 + E2 + S2 + D1		d2 : G3 + E2 + S2 + D2
e1 : G3 + E2 + S3 + D1		e2 : G3 + E2 + S3 + D2

It would be too cumbersome to give detailed results for all scenarios for all countries. They are presented for the standard scenario, scenario a1 only in tables A.16 for discards and table A.17 for new registrations. A summary is given below in tables 3.9 and 3.10. Results for scenarios a1, b1, c1, d1, e1 are summarized in tables A.18 and A.19.

As far as the second set of scenarios is concerned, there is virtually no effect of an increase in vehicle life on world rubber consumption because

- more tires are needed for replacement;
- this only concerns countries 1 - 25;
- rubber for passenger car tires only covers some 25 % of world rubber use.

Table 3.9. Projections of discards of passenger cars (in thousands) for the standard scenario (see text)

		1985	1990	1995	2000
I.	North America	10664.6	11805.0	11814.1	12905.5
II.	Asia, developed	2485.6	3363.2	4263.1	4562.9
III.	Oceania, developed	506.7	571.8	680.7	797.1
IV.	North-West Europe	7170.6	7991.5	8404.0	8756.4
V.	South-West Europe	2078.5	2400.5	2762.8	3111.5
VI.	Eastern Europe	1032.1	1250.8	1368.5	1805.5
VII.	Latin America + Caribbean	976.3	1320.6	1591.4	2260.3
IX.	South Asia	103.5	131.7	185.4	244.5
X.	South-East + East Asia	167.1	265.7	407.6	651.4
XI.	Middle-East + North Africa	278.6	326.1	341.2	462.7
XII.	Other Africa	334.7	434.2	591.6	773.4

Table 3.10. Projections of new registrations of passenger cars (in thousands) for the standard scenario (see text)

	1985	1990	1995	2000
I. North America	11328.0	13817.3	13610.1	14159.7
II. Asia, developed	3802.6	4507.5	4660.3	4725.2
III. Oceania, developed	748.1	850.4	917.3	941.0
IV. North-West Europe	8376.9	8939.7	8955.1	9094.5
V. South-West Europe	2946.4	3368.0	3598.8	3771.3
VI. Eastern Europe	1606.9	2066.3	2379.2	2880.6
VII. Latin America + Caribbean	1909.0	2961.5	3997.0	5337.6
IX. South Asia	235.8	307.8	410.9	504.5
X. South-East + East Asia	548.5	912.3	1465.5	2302.7
XI. Middle-East + North Africa	390.8	499.4	560.8	689.0
XII. Other Africa	717.5	934.4	1216.4	1513.7

Chapter 4. THE COMMERCIAL VEHICLE MARKET

4.1 Introduction

The conclusions from the remarks about the passenger car market in section 3.1 are as relevant for commercial vehicles as they are for passenger cars. A brief review will suffice.
When developing models and subsequently setting up projections for rubber demand, attention should be focussed on those factors concerning commercial vehicles which determine tire purchase and use. Tires are bought when attached to a new vehicle or to replace worn-out tires. Thus, emphasis must be placed on:

- how many new vehicles are purchased in order to determine the number of tires for original equipment;
- how many vehicles have driven how many kilometres and when will they consider their tires worn-out.

Analyzing the vehicle market as a whole for each country or region examined, certain closely related statistics are relevant:

- production of vehicles
- inventories of vehicles
- sales of vehicles
- new registration of vehicles
- total registration of vehicles (vehicles in use)
- discards of vehicles
- international trade in vehicles
- trade in used vehicles.

Similarly to section 3.1, one may argue for commerciel vehicles that

- trade in used vehicles will not affect use of tires;
- international trade in commercial vehicles can be omitted, as we focus on tire usage in the country of registration;

- for the same reason, production of commercial vehicles per country is not important;
- inventories of commercial vehicles need not be included, as the model is a long term one;
- data on new registration are more reliable than data on sale and will therefore be used instead.

This brings us to the relation between the remaining variables: commercial vehicles in use, new registrations and discards. A newly registered vehicle may be purchased for two reasons: either because a subject wants one (more) vehicle, not having one (or enough) or because it wants to replace a vehicle it is already using. The first case requires an increase in the "vehicle park"; the second case requires that the old vehicle will be sold to a subject wanting to use one (more) vehicle or to replace one it already uses. Replacement (the second case) goes on until the last subject in line only has the option of discarding (i.e. scrapping) its old vehicle or adding one more to his existing stock; the net result of the replacement sequence must therefore be discards. If a vehicle is discarded without being replaced, the number of vehicles in use will be reduced. The only problem is international trade in used cars. This is rather minor and does not disturb the picture. Thus, new registration can be divided into increase in the vehicle park and discards. This fact implies that it is not appropriate to explain new registration using a behavioural equation because it consists of a mix of elements with changing content. Discards can be related to lagged values of new registration.

4.2 Modeling commercial vehicles in use

The number of studies on this subject is remarkably smaller than in the case of passenger cars. The reasons for this presumably is less accessible data and more complex reality. The important variables are:

- commercial vehicles in use: X_1
- road transport in ton-kilometer: X_2
- average capacity of vehicles: X_3
- average degree of capacity utilization: X_4
- average distance: X_5

The relation between these given variables is:

$$X_2 = X_1 . X_3 . X_4 . X_5 \qquad (4.1)$$

So, ideally X_1 should be explained by

$$X_1 = \frac{X_2}{X_3 . X_4 . X_5} \qquad (4.2)$$

The main problem in empiricizing this equation is the data base. Data on the number of commercial vehicles in use (X_1) are available (see appendix, table A.20) and are of reasonable quality, although some modifications had to be introduced. Figures on road transport (X_2) are available for only a few countries (see table 4.1). Even more difficult to obtain is reliable information for most countries on the variables X_3, X_4 and X_5.

With regard to loading capacity (X_3), some statistics for some countries are shown in table 4.2. Because of international transport by commercial vehicles (c.v.) it is useful to calculate the average for these three countries on the European continent; these do not show any significant systematic change during 1963-1974. For the United Kingdom, data represent gross vehicle weight (G.V.W.) instead of loading capacity, as for the other countries. As these data are not completely comparable to those of the other European countries they must be treated separately. They show an increase up to 1970 and a decrease afterwards. However, the differences are not big and for the vehicle park as a whole this will not have much effect. A consistent series of figures for the United States over the period 1962-1974 was not available. The figures for 1970-1974 are lower than the figures for 1962-1970, possibly because buses have been excluded; there appears to be no over-all trend. Figures for Canada show a trend, but mixing this into United States figures eliminates its significance.

For almost all countries of the world, data on capacity utilization (X_4) and average driving distance (X_5) are too poor to permit any time series analysis. In other cases they do not vary over time.
All this means that there is no proper basis for an analysis of the relationship between commercial vehicles in use, X_1 and road transport, X_2. Since the elements of the denominator of relationship (4.2) do not seem to fluctuate much over time and their changes might even cancel out, these variables have not been used.

On the other hand, road transport is clearly related to the volume of over-all production, in this case represented by GDP. Taking all these aspects into account it has been decided to relate the number of vehicles in use directly to GDP.

Tabel 4.1 Road transport in ton-kilometre for some countries

	U.S.A.		W.Germany		France		United Kingdom[a]	
	Total ton-km (mill.)	Per C.V. (ton-km)	Total[b] ton-km (mill.)	Per C.V. (ton-km)	Total ton-km (mill.)	Per C.V. (ton-km)	Total ton-km (mill.)	Per C.V. (ton-km)
1963	541,047	39,451	28,700	32,800	37,100	34,448	57,000	33,275
1964	573,395	39,969	30,345	31,708	41,698	36,259	62,954	35,668
1965	578,061	38,498	32,627	37,719	46,857	38,629	67,000	37,409
1966	612,983	38,684	33,648	37,304	52,486	41,005	67,800	38,435
1967	625,212	37,820	33,878	37,980	53,684	40,003	70,300	38,584
1968	637,763	36,758	37,800	41,584	55,783	39,367	71,900	40,667
1969	650,158	35,626	39,900	42,222	64,900	42,923	72,800	41,223
1970	663,032	34,665	41,900	41,816	66,900	41,424	83,067	47,359
1971	691,999	34,308	44,500	42,421	-	-	85,029	48,394
1972	756,370	34,906	49,200	45,725	72,800[c]	39,934	84,000	47,138
1973	812,696	34,468	55,900	50,634	92,000[c]	46,629	91,610	49,173
1974	796,603	31,806	58,500	53,182	-	-	90,000	47,269
1975	712,920	28,703	-	-	-	-	86,800	45,421

Sources: United Nations, Annual Bulletin of Transport Statistics for Europe.
Motor Vehicle Manufacturers Association, Motor Vehicles Facts and Figures, 1975 and 1977.

Notes : a) Great Britain.
b) Long distance transport only. This refers to operations by vehicles authorized to carry goods to or from points more than 50 kms from the place where the vehicle is normally stationed.
c) Excluding traffic by vehicles whose carrying capacity is less than 1 ton.

c.v. = commercial vehicle.

Table 4.2 Capacity of commercial vehicles (in tons)

	(1) Italy-average loading capacity c.v. in use	(2) Italy-average laden weight c.v. in use	(3) Italy-ratio (1)/(2)	(4) France-average laden weight c.v. in use	(5) W.Germany average laden weight c.v. in use	(6) Average of France, W.Germany & Italy (2)(4)(5)	(7) United Kingdom average G.V.W. c.v. in use	(8) United States average G.V.W. sales trucks + buses	(9) United States as (8) domestic sales only	(10) United States as (8) trucks only	(11) United States as (9) trucks only	(12) Canada average G.V.W. trucks only	(13) Average USA + Canada (8), (12)
1961	4.3	7.9	0.54	-	4.8	-	-	-	-	-	-	-	-
1962	4.0	7.5	0.53	-	4.8	-	-	4.4	-	-	-	4.7	4.5
1963	4.2	7.7	0.55	4.0	4.9	4.4	4.6	4.3	-	-	-	4.6	4.3
1964	3.6	6.8	0.53	4.1	5.2	4.6	4.6	4.2	-	-	-	4.4	4.2
1965	2.8	5.1	0.55	3.8	5.5	4.4	4.8	4.1	-	-	-	4.3	4.1
1966	3.1	5.5	0.56	3.8	5.8	4.5	4.9	4.3	4.3	-	-	4.1	4.3
1967	3.4	6.1	0.56	3.8	5.6	4.3	5.0	4.3	4.2	-	-	4.7	4.3
1968	3.5	6.3	0.56	3.8	5.6	4.5	5.1	4.1	4.0	-	-	3.5	4.0
1969	3.3	5.9	0.56	3.8	5.8	4.5	5.2	4.4	4.2	-	-	3.7	4.3
1970	3.4	6.1	0.56	3.9	6.3	4.8	5.3	4.3	4.2	4.2	-	4.1	4.2
1971	3.4	5.8	0.59	3.7	6.6	4.8	4.9	-	-	-	3.9	-	-
1972	3.3	5.6	0.59	3.5	6.1	4.5	4.4	-	-	-	3.9	-	-
1973	3.4	6.0	0.57	3.4	6.4	4.4	4.7	-	-	-	3.9	-	-
1974	3.7	6.5	0.57	3.4	7.4	4.6	4.8	-	-	-	4.0	-	-
1975	-	-											

Source: Calculated from World Motor Vehicle Statistics and Facts and Figures, Motor Vehicle Manufacturers Association, United States of America.

c.v. = commercial vehicle.
G.V.W. = gross vehicle weight.

4.3 Historical developments, models and projections

Above it was concluded that a relationship between commercial vehicles in use and GDP should yield a good model. Scatterdiagrams from some countries will illustrate this statement (cf. figure 4.1).

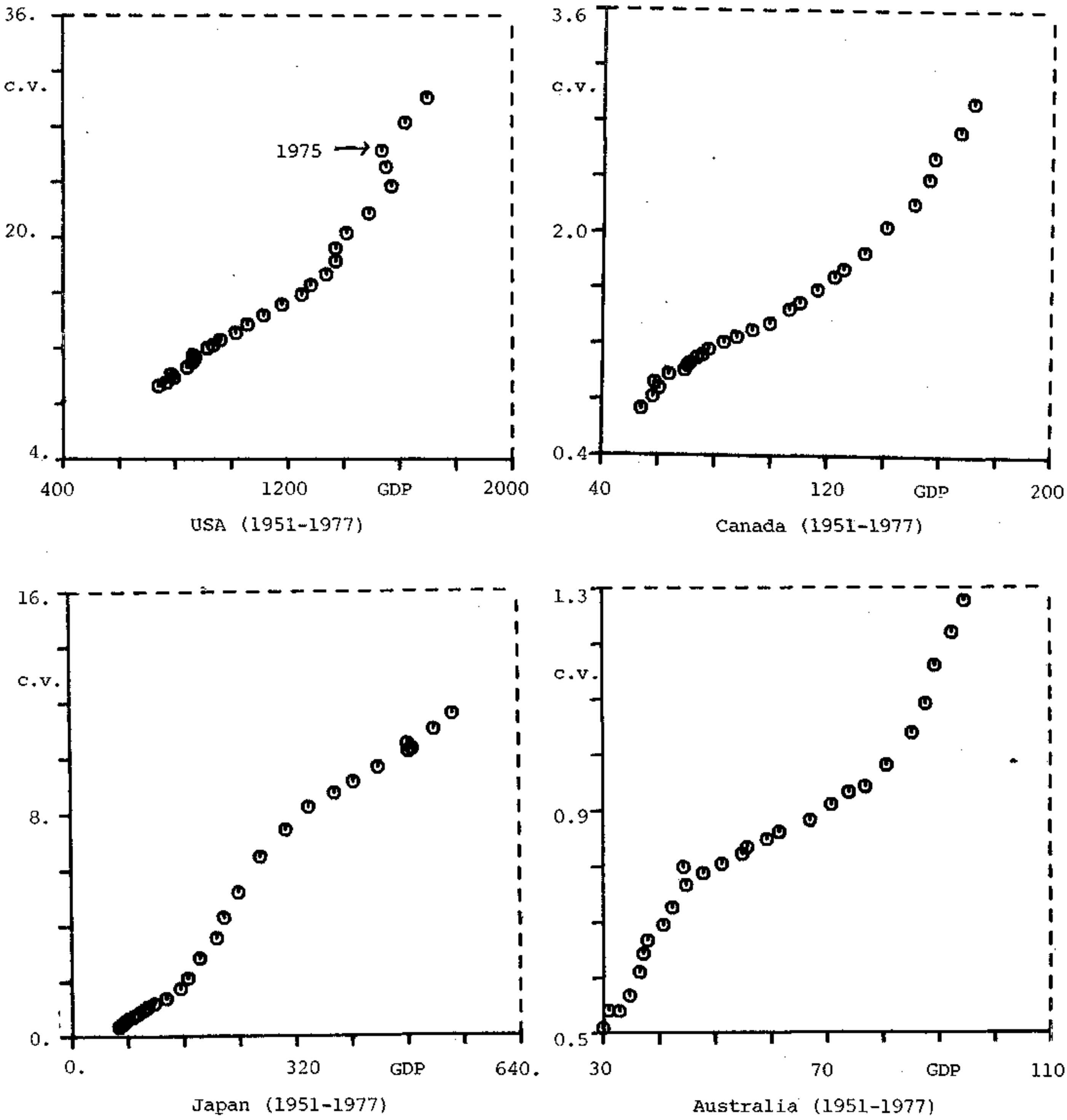
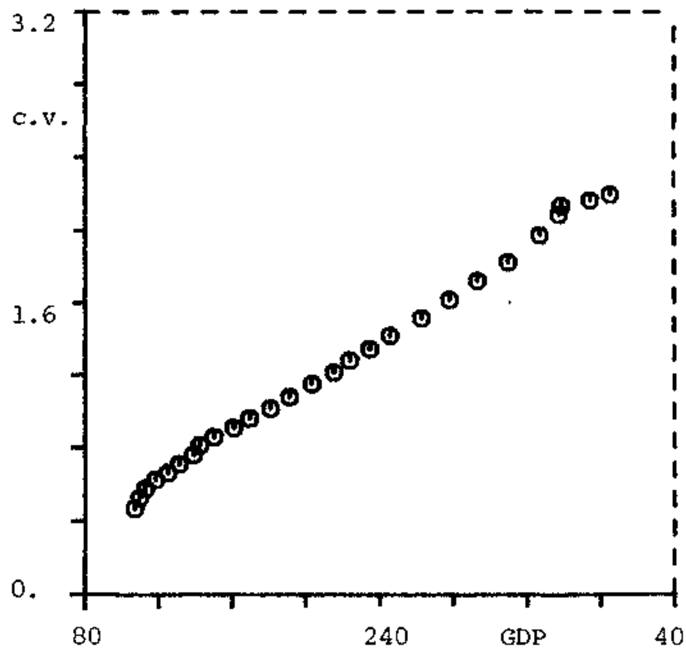
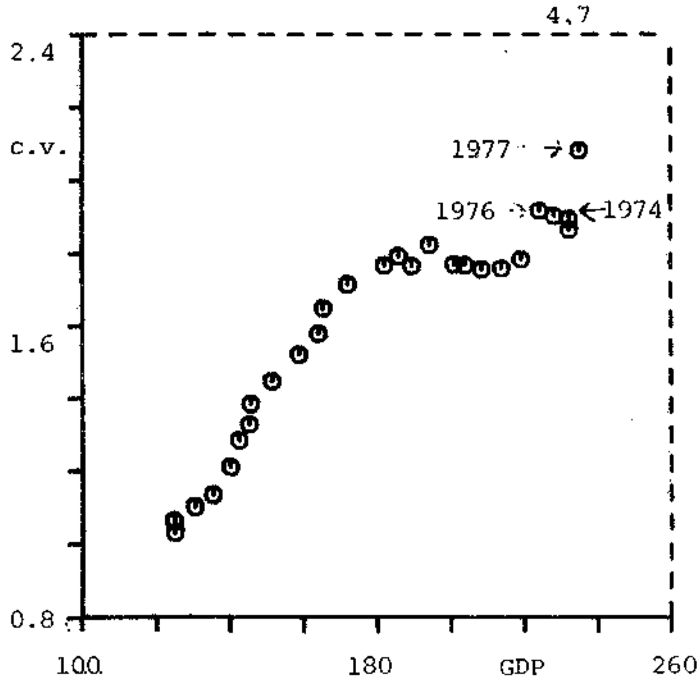


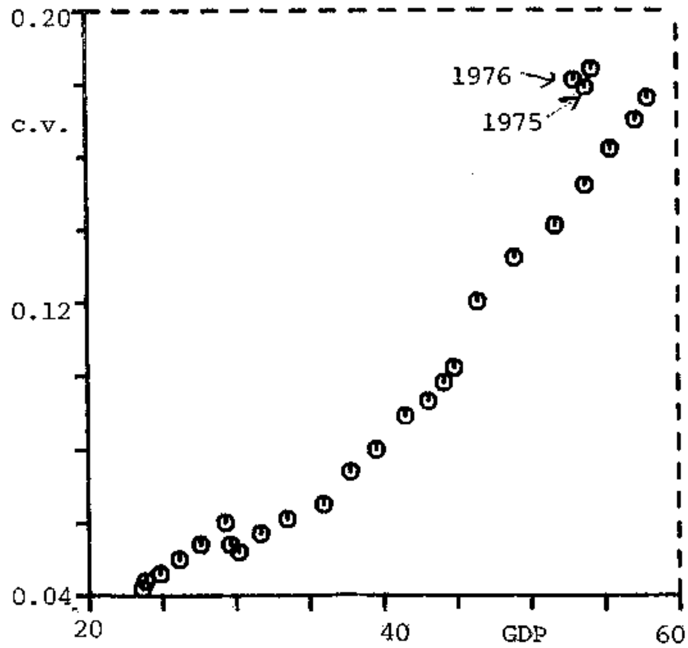
Figure 4.1 Scatterdiagram between commercial vehicles (c.v., * 10^6) and income (GDP, * 10^9 1975 constant US $).



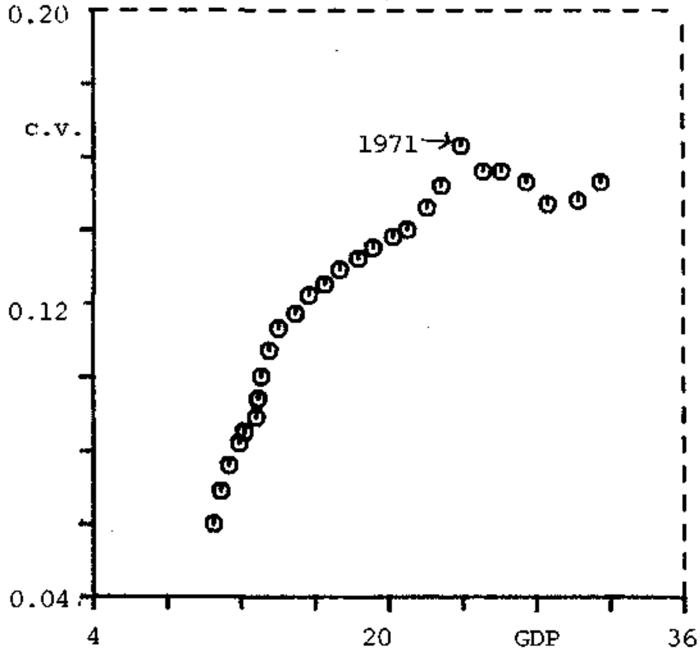
France (1951-1977)



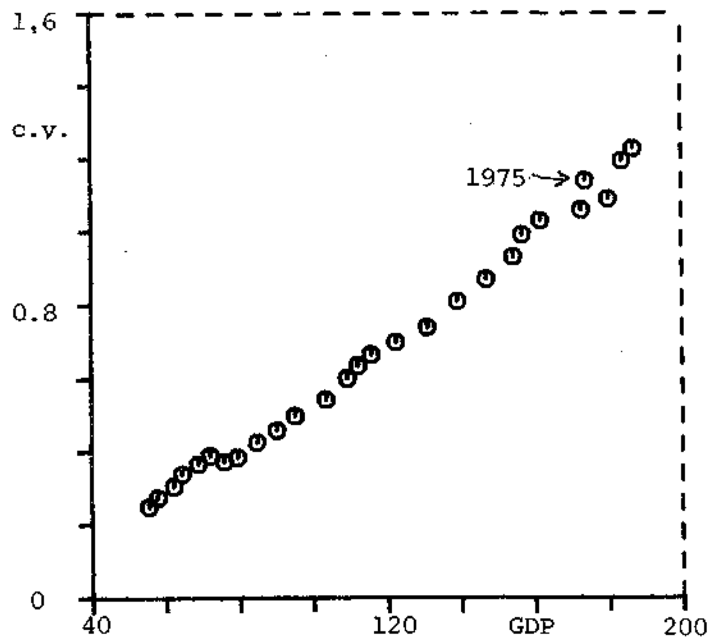
United Kingdom (1951-1977)



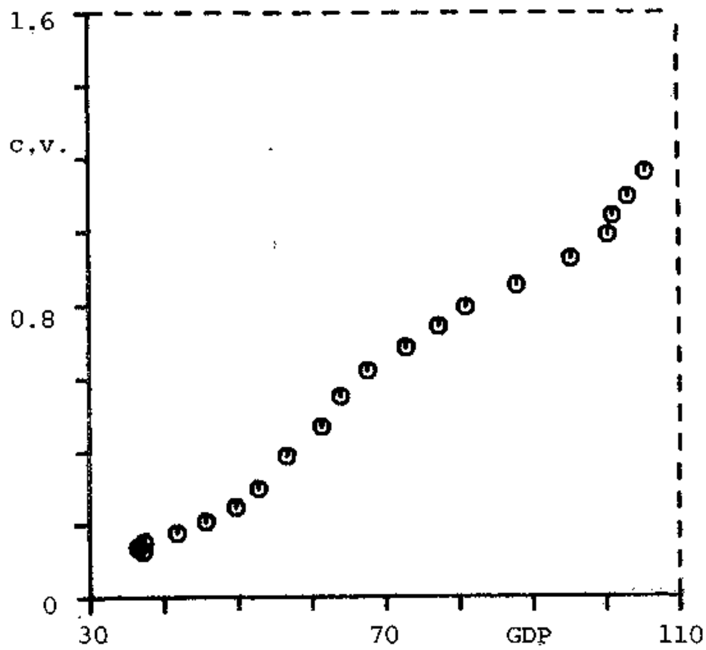
Switzerland (1951-1977)



Norway (1951-1977)



Italy (1951-1977)



Spain (1951-1977)

Figure 4.1 (continued)

Most of the countries show a rather straightforward relationship between commercial vehicles in use and total GDP.
The reaction to the oil crisis is very interesting. Three patterns can be distinguished:

a) negative or low growth in GDP and hardly any change in the pattern of the number of commercial vehicles in use, cf. United States, Canada, United Kingdom, Switzerland, Italy and Spain;
b) hardly any growth, both in GDP and the number of commercial vehicles in use, cf. Japan and France;
c) no change in pattern of development both in GDP and commercial vehicles in use, cf. Australia.

If growth in commercial vehicles in use does not respond immediately to (reductions in) growth in GDP, one may expect some adjustments in de medium term.
A model which has these characteristics is the partial adjustment model.
It is based on the assumption that at a given level of GDP, Y_t, there is an optimal level of commercial vehicles in use Z_t^*. Adjustment to this optimal level is not fully realized; the fraction is γ. The model now is described as

$$Z_t^* = \alpha_0 - \alpha_1 Y_t \tag{4.3}$$

$$Z_t - Z_{t-1} = \gamma (Z_t^* - Z_{t-1}) + u_t \tag{4.4}$$

Substitution of the unknown Z_t^* from (4.3) into (4.4) gives

$$Z_t = \alpha_0\gamma + \alpha_1\gamma Y_t + (1-\gamma) Z_{t-1} \tag{4.5a}$$

For some countries, a multiplicative approach to (4.3) and (4.4) proved more useful, resulting in

$$\ln Z_t = \alpha_0\gamma + \alpha_1\gamma \ln Y_t + (1-\gamma) \ln Z_{t-1} \tag{4.5b}$$

In some cases it was not possible to include $\gamma \neq 1$. This leaves us with

$$Z_t = \alpha_0 + \alpha_1 Y_t \tag{4.5c}$$

or

$$\ln Z_t = \alpha_0 + \alpha_1 \ln Y_t \tag{4.5d}$$

For a few countries, a linear trend has been supplemented. A review of the model approach per country or group of countries is given in table 4.3.

Table 4.3 Specification of equation 4.5 per region.

	Specification code*)		Specification code*)
1. United States	c	20. Spain	c
2. Canada	b	21. Portugal	a
3. Japan	c	22. Greece	c
4. Australia	a	23. Turkey	a
5. New Zealand	a	24. Yugoslavia	a
6. Germany, F.R.	a	25. Other W.Europe	c
7. France	a	26–32. E.Europe	c
8. United Kingdom	c	33. Brazil	c
9–10. Benelux	-	34. Argentina	a
11. Denmark	a	35. Mexico	a
12. Iceland	a	36. Other Latin America	a
13. Sweden	a	39. India	a
14. Switzerland	a	40–43. Other S.Asia	a
15. Ireland	a	44–52. E. + S.E.Asia	a
16. Norway	c	53–54. M.E. + N.Africa, oil	a
17. Finland	a	55. M.E. + N.Africa, others	a
18. Austria	c	56–58. Other Africa	a
19. Italy	a		

*) code a, b, c, d refer to equation 4.5a, b, c, d.

For projection purposes, we again must base our calculations on the scenarios for future economic growth as described in chapter 2, and presented in detail in table A.9. As far as the energy aspect is concerned we have the strong impression that there is no important effect other than through economic development in general. Projections for three GDP-scenarios are presented in table A.21 and summarized for broad regions in table 4.4 below.

Table 4.4 Projections of commercial vehicles in use, for 3 economic scenarios. (in thousands)

		scenario	1985	1990	1995	2000
I.	North America	G1	36344.4	40354.2	44716.7	47968.2
		G2	39260.5	47756.9	57711.2	67390.4
		G3	41297.6	53233.3	67891.4	83524.0
II.	Asia, developed	G1	17866.2	23004.3	29407.3	36429.6
		G2	18784.8	26154.7	36017.3	47995.6
		G3	19627.9	28738.8	41517.3	57994.5
III.	Oceania, developed	G1	1769.8	1922.8	2113.5	2308.9
		G2	1810.3	2081.9	2453.2	2885.8
		G3	1846.9	2214.2	2735.2	3380.1
IV.	North-West Europe	G1	8870.5	9892.6	11098.9	12264.0
		G2	9173.7	10861.3	13001.5	15356.0
		G3	9433.2	11646.0	14568.3	18004.2
V.	South-West Europe	G1	4325.0	4854.7	5482.3	6083.4
		G2	4493.1	5416.1	6594.7	7887.0
		G3	4645.4	5881.2	7521.9	9443.0
VI.	Eastern Europe	G1	8388.6	9458.6	10634.8	11851.0
		G2	8483.8	9776.8	11287.1	12968.6
		G3	8571.2	10037.9	11830.3	13935.7
VII.	Latin America + Caribbean	G1	6191.4	7402.8	8974.7	10797.1
		G2	6371.9	8082.1	10465.7	13469.2
		G3	6532.6	8643.5	11701.9	15759.7
IX.	South Asia	G1	1472.8	1872.3	2394.6	3009.0
		G2	1530.2	2078.1	2846.3	3836.7
		G3	1582.9	2246.8	3221.8	4551.0
X.	South East + East Asia	G1	2465.3	3393.4	4661.6	6245.0
		G2	2577.0	3810.6	5616.9	8072.5
		G3	2679.3	4152.2	6409.7	9646.9
XI.	Middle East + North Africa	G1	2864.6	4068.1	5619.6	7407.6
		G2	3055.2	4736.8	7059.2	9997.7
		G3	3219.4	5271.9	8239.7	12214.3
XII.	Other Africa	G1	2238.7	2535.7	2869.9	3143.8
		G2	2386.1	2978.0	3684.8	4398.8
		G3	2521.4	3341.6	4365.5	5489.5
	World, excl. Asian Centrally Planned Economies	G1				
		G2				
		G3				

4.4 Discards and new registrations of commercial vehicles

For commercial vehicles the same model as for passenger cars has been used. It has been elaborated in 3.6 and will be only briefly reviewed here. An approach following the lines of a mortality tables looks most promising. Unfortunately, accurate mortality tables are available for a few countries only. And again one often encounters data on vehicles in use by model year rather than by year of registration. As many vehicles of a certain model year are sold and registered in the following year or later, usage of these kinds of tables introduces considerable inaccuracies.

Basically the model to be used is (cf. section 2.1)

$$G_t = \Delta Z_t^T + H_t \tag{4.6}$$

$$H_t = f\ (G_{t-k}),\ k = 0, 1, 2, \ldots k^{max} \tag{4.7}$$

where G_t = new registrations

Z_t^T = total registrations = total number of commercial vehicles in use

H_t = discards = deregistration.

In this section, we focus on discards H_t and thus on equation (4.7). Afterwards, new registrations G_t are calculated using (4.6).

The most important reason for a commercial vehicle to be discarded is its age. However, life of a vehicle will be different for each vehicle. Using United States time series data on vehicles constructed in a particular year, and calculating the share of these vehicles still in use after k years, the pattern roughly is as plotted in figure 3.6 in chapter 3. This means that during some years (where k is small) the share hardly decreases. Over time the share decreases more and more rapidly, so that the probability of a particular vehicle being discarded increases more and more until the point of inflexion (in figure 3.6) reached at age k^*. After this point the rate of decrease in share declines so that the probability of discarding declines also. The probability curve for this time series is shown in figure 3.7.

A way of dealing with the problem of obtaining coefficients β_k following the shape of the lag distribution, is to assume that the lag coefficients follow the pattern of probability density functions. We have selected three types with mean μ and standard-deviation σ (cf. section 3.6).

a. Poisson distribution

b. Logistic distribution

c. Normal distribution.

Now criteria have to be established to choose among probability distributions and to estimate μ and σ. Generally speaking, expected discarding $\hat{H}_t$ should give a good fit to actual discarding H_t. This can be quantified in two ways:

1. Minimize $c_1 = \dfrac{\Sigma\ (H_t - \hat{H}_t)^2}{\Sigma\ (H_t - \bar{H})^2}$

   where $\bar{H}$ is the mean of H_t.

2. Minimize $c_2 = \Sigma({}^{H}t/_{\hat{H}_t} - 1)^2$

This latter criterion is based on the assumption that the ratios of H_t and $\hat{H}_t$ should roughly equal 1.

It is realistic to assume that suitable aggregation of similar countries hardly affects the results of the analysis, because scrapping behaviour will be rather similar. If data permit, for these groups of countries, optimal specifications and values of parameters can be specified. Of course, the most interesting part is average life of commercial vehicles. Contrary to the case of passenger cars, lack of data or estimation results for most countries forced us to derive information about average life with less advanced methods. Results are shown in table 4.5.

Projection results are presented in table A.22 for discards and table A.23 for new registrations and summarized by broad regions in tables 4.6 and 4.7.

Table 4.5 Average life of commercial vehicles

Country or group of countries		Average life of commercial vehicles in years
1.	United States	16
2.	Canada	16
3.	Japan	10
4-5.	Australia + New Zealand	15
6.	Germany F.R.	14
7.	France	14
8.	United Kingdom	14
9-14.	N.W. Europe	14
15-18.	N.W. Europe	14
19.	Italy	13
20-25.	S. Europe	13
26-32.	E. Europe	14
33-36.	Latin America	15
39-43.	S. Asia	15
44-52.	E. + S.E. Asia	15
53-54.	Middle East + N. Africa (oil)	14
55-58.	Other M.E. + Africa	15

Table 4.6 Projections of discards of commercial vehicles (in thousands) for three scenarios (see text)

			1985	1990	1995	2000
I.	North America	G1	2104.9	2662.2	2510.6	2529.2
		G2	2106.2	2695.7	2740.3	3123.7
		G3	2106.7	2712.7	2885.1	3569.3
II.	Asia, developed	G1	1649.0	2234.5	2603.6	3305.1
		G2	1650.6	2303.7	2899.5	3933.1
		G3	1651.9	2361.8	3148.7	4447.7
III.	Oceania, developed	G1	106.5	126.5	127.2	135.7
		G2	106.5	126.9	131.3	150.6
		G3	106.5	127.3	134.9	163.2
IV.	North-West Europe	G1	849.5	877.2	921.8	1020.8
		G2	849.8	882.6	960.0	1125.2
		G3	849.9	886.4	992.2	1211.0
V.	South-West Europe	G1	259.9	315.5	333.4	383.8
		G2	260.0	319.3	361.3	454.2
		G3	260.1	322.5	385.2	512.4
VI.	Eastern Europe	G1	669.7	749.7	782.5	882.1
		G2	669.7	751.3	795.0	916.9
		G3	669.8	752.7	805.6	945.7
VII.	Latin America + Caribbean	G1	328.8	393.6	440.8	531.4
		G2	328.9	395.5	459.2	595.7
		G3	328.9	397.1	474.6	649.4
IX.	South Asia	G1	44.7	68.3	96.5	118.1
		G2	44.7	69.0	102.5	137.6
		G3	44.7	69.6	107.5	153.7
X.	South-East + East Asia	G1	97.6	160.6	193.9	257.4
		G2	97.7	151.9	205.6	297.2
		G3	97.7	163.0	215.5	330.1
XI.	Middle-East + North Africa	G1	71.5	98.9	92.7	111.8
		G2	71.5	99.7	98.9	128.7
		G3	71.6	100.2	103.2	141.4
XII.	Other Africa	G1	156.7	201.2	274.9	370.6
		G2	156.8	204.8	304.3	460.2
		G3	156.9	207.7	329.2	534.7

Table 4.7 Projections of new registrations of commercial vehicles (in thousands) for three scenarios (see text)

			1985	1990	1995	2000
I.	North America	G1	2413.0	3492.5	3411.8	3189.5
		G2	2937.8	4507.6	4855.5	5154.6
		G3	3484.1	5304.3	6057.6	6913.9
II.	Asia, developed	G1	2451.7	3354.5	3999.4	4821.8
		G2	2688.2	3954.2	5108.3	6591.9
		G3	2933.0	4438.5	6061.4	8170.6
III.	Oceania, developed	G1	131.9	160.2	168.4	175.3
		G2	145.2	189.6	213.5	242.7
		G3	153.1	213.2	252.0	303.5
IV.	North-West Europe	G1	996.3	1097.6	1177.4	1250.3
		G2	1072.2	1257.8	1426.0	1626.3
		G3	1150.4	1384.8	1638.6	1957.4
V.	South-West Europe	G1	349.1	429.7	466.4	506.4
		G2	394.7	525.3	617.4	727.7
		G3	440.7	561.9	747.5	927.5
VI.	Eastern Europe	G1	862.9	971.5	1027.4	1134.7
		G2	886.9	1025.4	1117.6	1275.8
		G3	911.8	1068.7	1195.6	1404.0
VII.	Latin America + Caribbean	G1	519.0	664.5	786.2	922.2
		G2	572.2	790.2	995.5	1258.5
		G3	625.9	890.6	1173.9	1561.5
IX.	South Asia	G1	106.6	157.0	212.5	253.3
		G2	121.6	193.9	277.6	361.4
		G3	137.2	223.5	333.6	459.4
X.	South-East + East Asia	G1	239.6	370.1	480.2	611.9
		G2	269.5	447.6	624.1	861.5
		G3	300.3	509.9	747.4	1086.7
XI.	Middle-East + North Africa	G1	102.2	141.7	144.1	163.9
		G2	114.1	167.4	186.0	227.9
		G3	123.2	187.5	220.7	284.1
XII.	Other Africa	G1	352.1	486.3	636.3	767.4
		G2	424.2	644.9	895.3	1174.0
		G3	499.5	772.3	1119.5	1544.6

Chapter 5. TIRES

5.1 Introduction

In chapters 3 and 4 projections were derived of the number of vehicles in use, new registrations and discards of vehicles both for passenger cars and commercial vehicles. This detailed analysis of the basic indicators of the size and the growth of the vehicle park was necessary in order to determine the demand for tires. As has been pointed out previously, new registrations of vehicles can be used as the variable determining the demand for tires for original equipment. The demand for tires for replacement purposes, however, is determined by vehicles in use less that year's discards.

These relationships will be discussed in somewhat greater detail in the present chapter, together with the related issue of the demand for new tires versus retreads. As in previous chapters, our purpose in entering into this description is to provide the essential methodology underlying our demand projections. The relationships referred to in this chapter are illustrated in figure 5.1.

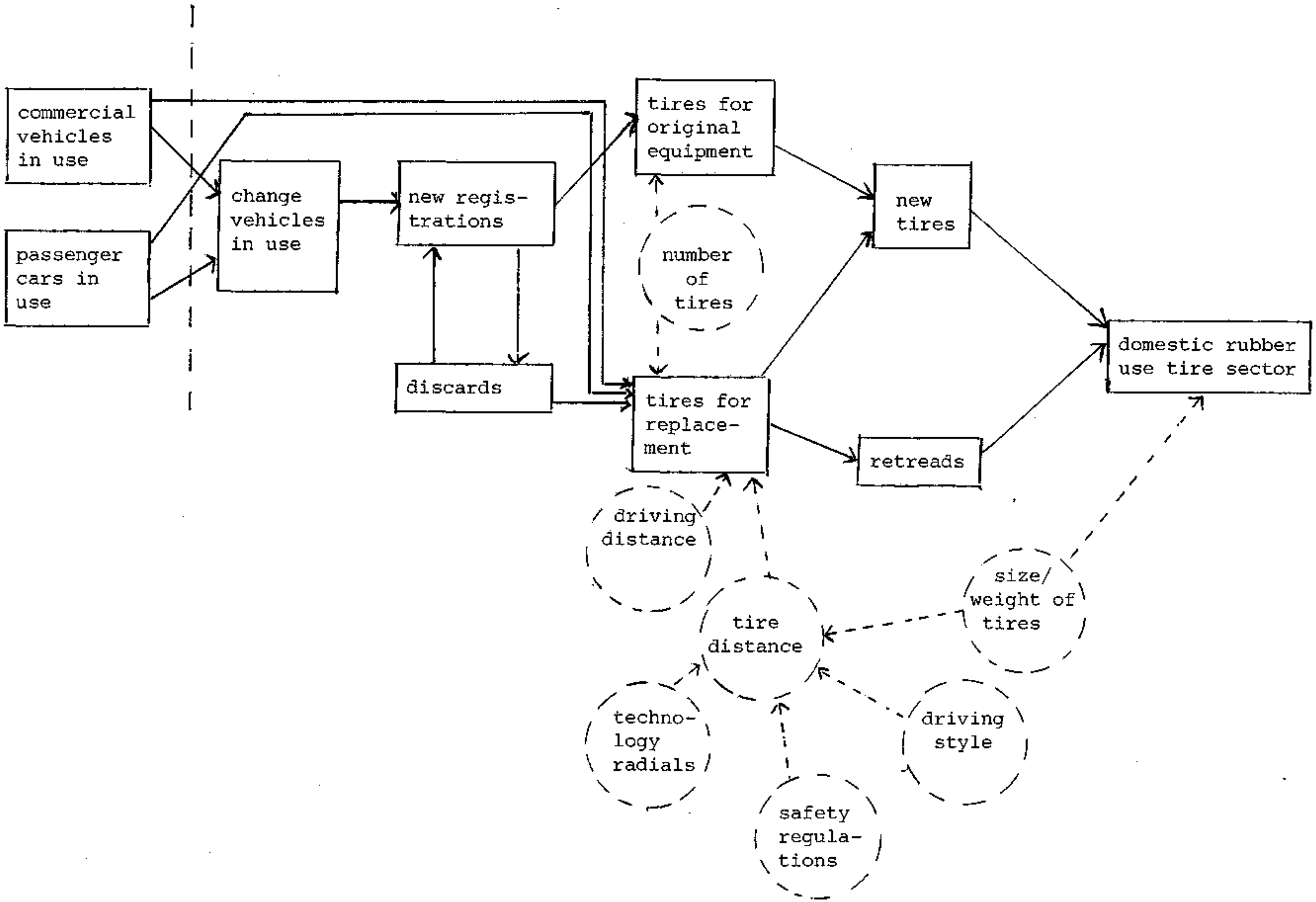


Figure 5.1 Relationships concerning rubber use in the tire sector.

5.2

5.2 Tires for original equipment

First, passenger cars will be discussed. Nobody will question the statement that over 99.9 per cent of passenger cars nowadays are driving around on four wheels, and it does not seem likely that this will change in the near future. What is of major importance is the presence of the spare tire, which means that virtually all new cars are equipped with five tires. However, newly developed tires (so-called safety tires or un-flat tires) scheduled to be introduced in the near future may have an impact on this variable because of their ability to cover a considerable distance after puncture. Owing to the chemical composition of these tires, little or no manoeuvrability is lost after puncture and this enormously reduces the danger of accident after puncture. The share of this new system of tires will increase over time depending on the country. This phenomenon will reduce the average number of tires per new passenger car. It is expected that this trend will develop along the lines shown in table A.24 and this development has been included in our projections.

The projections of new registrations (cf. chapters 3 and 4) have been the basis for the disaggregation into conventional tires and radial tires because, as mentioned before, radial tires are heavier and use more rubber than conventional tires and because the share of NR in the elastomer content of radials is far higher. Projections of the share of radials, based on the data in table A.25, are presented in table 5.1. Multiplying projections of tires for original equipment with the shares of conventional tires and radials gives the component projections for conventional tires and radial tires, presented in table A.26.

For commercial vehicles it is extremely difficult to obtain adequate statistical information on the number of tires per vehicle. The main determinant is the average size. Table A.27 shows that for some European countries the share of bigger commercial vehicles in use has been increasing except for Italy. This is partly reflected in table A.28, which shows the share of big commercial vehicles in production. The dominant role of big commercial vehicles is intensified by the fact that the life of small commercial vehicles is shorter than the life of big commercial vehicles. As to United States factory sales (table A.29), shares of different size of vehicles did not change much over time. Ideally, commercial vehicles should be divided into groups according to size, especially since very small commercial vehicles normally use passenger car tires.

Table 5.1 Projections of percentage share of radial tires

			1980	1985	1990	1995	2000
1	United States	Pass. car: o.e.	80	90	95	100	100
		: Rep.	55	80	95	100	100
		Com. veh.: Total	60	80	95	100	100
2	Canada	Pass. car: o.e.	80	90	95	100	100
		: Rep.	60	80	95	100	100
		Com. veh.: Total	60	80	95	100	100
3	Japan	Pass. car: Total	65	85	95	100	100
		Com. veh.: Total	55	75	90	95	100
4-5	Australia and New Zealand	Pass. car: Total	60	80	95	100	100
		Com. veh.: Total	50	70	90	95	100
6	Germany, F.R.	Pass. car: Total	90	95	100	100	100
		Com. veh.: Total	85	95	100	100	100
7	France	Pass. car: Total	100	100	100	100	100
		Com. veh.: Total	100	100	100	100	100
8	United Kingdom	Pass. car: o.e.	100	100	100	100	100
		: Rep.	85	95	100	100	100
		Com. veh.: Total	85	95	100	100	100
9-14	Northern Europe I	Pass. car: Total	90	95	100	100	100
		Com. veh.: Total	90	95	100	100	100
15-18	Northern Europe II	Pass. car: Total	90	95	100	100	100
		Com. veh.: Total	90	95	100	100	100
19	Italy	Pass. car: Total	95	100	100	100	100
		Com. veh.: Total	90	95	100	100	100
20-25	Southern Europe	Pass. car: Total	85	95	100	100	100
		Com. veh.: Total	70	85	95	100	100
26-32	Eastern Europe	Pass. car: Total	40	60	80	90	95
		Com. veh.: Total	30	50	70	85	95
33-36	Latin America	Pass. car: Total	40	60	80	90	95
		Com. veh.: Total	30	50	70	85	95
39-43	S. Asia	Pass. car: Total	20	40	60	70	80
		Com. veh.: Total	20	40	60	70	80
44-52	E. + S.E. Asia	Pass. car: Total	50	70	90	95	100
		Com. veh.: Total	40	60	80	90	95
53-54	M.E. + N.Africa	Pass. car: Total	50	70	90	95	100
		Com. veh.: Total	40	60	80	90	95
55-58	Other M.E. + Africa	Pass. car: Total	20	40	60	70	80
		Com. veh.: Total	20	40	60	70	80

This has been attempted but the results are not yet very sound, the main bottle-neck being availability of data. Only the aggregate result is therefore presented. In consultation with experts and on the basis of several publications reasonable information has been obtained for some years and for some countries on the number of tires per commercial vehicle. It has been assumed (for want of different evidence) that commercial vehicle size, and therefore the number of tires per commercial vehicle, will not change on average over the foreseeable future. Thus, projections to the year 2000 on the number of tires per commercial vehicle have been derived (see table A.30). By simply multiplying these data by the number of commercial vehicles newly registered, it is possible to make projections of the number of tires for original equipment (see table A.31), divided into conventional and radial tires (cf. table 5.1).

5.3 Tires for replacement

In chapter 1 some of the factors relevant to replacement of tires have been indicated. The conclusion was that tire life on average can be derived from tire distance over driving distance per year.

Regarding average driving distance per year, it is hard to obtain adequate information; some scattered data for passenger cars and commercial vehicles, however, are shown in table A.32a and A.32b. Analysing driving distance for passenger cars for some countries,it becomes clear that while there is some variation over time for all countries there is far greater variation among countries. This may be due partly to the method of data collecting. Some general conclusions for some developed countries can be drawn from regression analyses. It was found, first, that income has a very small positive influence for most of the countries investigated. Second, the number of cars in use per 1,000 persons has a negative influence; this can be explained by the growing incidence of second and third cars in a family, by worsening traffic congestion and by the increasing number of cars used solely for holiday purposes. Third, gasoline prices, of course, show a negative coefficient; it can be assumed, however, that the estimated coefficient was too high because driving distance during 1974 was mainly influenced by temporarily extreme oil shortages, as well as the temporarily extreme reaction thereto, whereas gasoline price showed very little increased, if any.

Using the above factors projections have been made (see table A.33). These show that for the United States and Canada the slightly declining trend will continue, becoming more pronounced in the middle of the 1980s. Japan has already experienced a steep decrease in driving distance; this is leveling off and we assume that the minimum will be reached at 8,000 km per year. Car density will become an extremely important factor for Western Europe and to a lesser extent for Oceania if it is regarded as proportional to country size and population density. Projections for Eastern Europe, being constant over time, may be as good as any other. Although traffic congestion is becoming more and more important in developing countries' major cities, it is not expected to become a more important factor than income increase for the next 10 years for Latin America and for the next 15 years for the other developing countries.

For commercial vehicles we expect increasing influence from other modes of transport such as container transport by train, particularly for developed countries. Driving distance is therefore projected to decrease slightly by 100 km per year in developed countries (table A.34).

Tire life can again be derived from tire distance. The actual procedure of estimating average tire distance is discussed below. An especially important factor in determining tire distance is the share of radial tires (see tables A.25 and 5.1). To incorporate this factor, conventional tires and radial tires have been separated into two distinct groups. Tire distance was estimated for each of them. Conventional tires may even further be subdivided into cross-ply and bias-belted tires and radial tires into textile radials and steel radials, the latter running considerably more kilometres. These differences have been taken into account wherever possible.

Some other factors affecting tire distance change over time and differ among countries. Two types of factors are relevant. The first is the security aspect, be it legal or personal. In the United Kingdom, for instance, tire distance has decreased considerably as a result of increased safety consciousness; in particular, a 1968 law on the quality of tires created a boom in the demand for replacement tires. Safety consciousness and security regulations also provide a major explanation of the difference in tire distance among countries. Tire distance in many developing countries, by comparison, can on these terms be expected to be relatively high.

The second influence on tire distance consists of factors like the positive relationship of tire weight and size to tire distance. This is the main cause, for instance, of the difference in tire distance between the United States and Japan. We have already mentioned driving style and road conditions: how powerful are the engine and the brakes; is the road a congested city street, a super highway or a dirt road; is driving over 100 km per hour allowed and so forth?

The estimation for average tire distance therefore has to be done on a regional basis and should include the possibility of changes over time. It is clear that both driving distance per year and tire distance for a particular person are different from the average. A probability distribution for actual tire distance as related to average tire distance and its standard deviation has therefore been included. Using this probability distribution, estimates for average and standard deviation were obtained by fitting estimated replacement of tires to actual replacement of tires. This did not yield good results for all regions of the world. For certain regions, estimates have therefore been made by comparison with regions for which good estimates exist, taking into account the above-mentioned factors which influence tire distance, i.e. security regulations and safety consciousness, tire size and weight, driving style and road conditions.

An extremely important problem in estimating tire distance is the availability of accurate properly disaggregated data. We shall just mention a few aspects of the tire data, which are a cause of inaccuracy:

- An important category of vehicles is the car derived van, which is of the passenger car stationswagon type constructed for transportation of goods. They use normal or slightly reinforced passenger car tires, which can not be found separately in data sources.
- Some other light vans (pick-up trucks etc.) may use reinforced passenger car tires as well.
- Tires for replacement can be either new tires or retreaded tires. Vast improvements in technology in recent years have succeeded in raising tire distance for a retreaded tire to about the same level as for a new tire. For this reason no reduction was made in tire distance for retreaded tires compared to new tires. The share of retreading in total tire replacement for passenger cars has decreased in the 1970s mainly due to the already longer life of radial tires, technical difficulties in adequately retreading a radial tire and insufficient supply of tires to be retreaded. Since the tire industry now seems to have overcome these problems and because of

related material savings and lower prices, an increased retread share is expected in the future (see table A.35). Data about retreads, understandably, are not very good.

- For commercial vehicles retreading has remained very important due to the relatively high share of tire costs in total costs of running a commercial vehicle.After consultation of expert opinion from industry sources, the share of retreaded tires in total replacement has been assumed to develop in the future as presented in table A.36.
- An other important factor affecting tire distance for heavy commercial vehicles is the possibility of regrooving: as the tread cannot be too thick for stability reasons and the belt consists of a rather thick layer of rubber, some 2-3 millimetres can be cut out after the depth of the tread has reduced. This will again add to tire distance.
- Imports of tires by domestic tire manufacturers may not have been properly distinguished from domestic production. Black imports may also affect accuracy.

It is essential, in conclusion, to be careful with estimation results, to incorporate results from other studies or expert opinions and to compare with aggregate production of all tires for the world as a whole.

The second step, of course, is to make projections of tire distance for the future. It has been assumed that there will be an increase in tire distance mainly for radial tires due to technological improvements; effects of possible changes in other factors influencing tire distance have been neglected because they are hard to predict. Projections for 1980-2000 are presented for passenger car tires and commercial vehicle tires in tables 5.2 and 5.3, respectively.

The third step has been to use these projections to determine tire demand projections. Using the probability distribution for tire distance, including projected average tire distance and comparing this with projections of driving distance per year, projections of the demand for tires for replacement for passenger cars and commercial vehicles have been made. The results appear in tables 5.4 to 5.7 and tables A.37 to A.42.

Table 5.2 Projected tire distance per year per passenger car in use, conventional and radial. (thousands of kilometres)

			1980	1985	1990	1995	2000
1.	United States	C	33.3	34.2	35.1	36.0	37.0
		R	51.7	52.7	53.6	54.5	55.4
2.	Canada	C	33.3	34.2	35.1	36.0	37.0
		R	51.7	52.7	53.6	54.5	55.4
3.	Japan	C	24.5	25.9	27.3	28.6	30.0
		R	43.9	46.2	48.5	50.8	53.1
4-5.	Oceania	C	30.5	31.4	32.3	33.3	34.2
		R	50.4	51.7	53.1	54.5	55.9
6.	Germany, Federal	C	29.1	30.5	31.9	33.3	34.7
	Republic of	R	48.5	50.8	53.1	55.4	57.8
7.	France	C	19.9	21.3	22.6	24.0	25.4
		R	46.7	49.0	51.3	53.6	55.9
8.	United Kingdom	C	27.3	28.6	30.0	31.4	32.8
		R	46.7	49.0	51.3	53.6	55.9
9-14.	Northern Europe I	C	26.3	27.7	29.1	30.5	31.9
		R	43.9	46.2	48.5	50.8	53.1
15-18.	Northern Europe II	C	26.3	27.7	29.1	30.5	31.9
		R	43.9	46.2	48.5	50.8	53.1
19.	Italy	C	26.3	27.7	29.1	30.5	31.9
		R	42.5	44.4	46.2	48.0	49.9
20-25.	Southern Europe	C	26.3	27.7	29.1	30.5	31.9
		R	40.7	42.5	44.4	46.2	48.0
26-32.	Eastern Europe	C	26.3	27.7	29.1	30.5	31.9
		R	38.8	40.7	42.5	44.4	46.2
33-58.	Rest of the world	C	26.3	27.7	29.1	30.5	31.9
		R	36.5	37.9	39.3	40.7	42.0

Notes: C = Conventional tires
R = Radial tires

Table 5.3 Projected tire distance per year per commercial vehicle in use, conventional and radial (thousands of kilometres).

			1980	1985	1990	1995	2000
1.	United States	C	45.2	47.4	49.5	51.7	53.8
		R	72.3	75.8	79.2	82.7	86.1
2.	Canada	C	45.2	47.4	49.5	51.7	53.8
		R	72.3	75.8	79.2	82.7	86.1
3.	Japan	C	31.9	33.6	35.3	37.0	38.7
		R	54.2	56.8	59.4	62.0	64.6
4-5.	Oceania	C	40.9	43.1	45.2	47.4	49.5
		R	72.3	75.8	79.2	82.7	86.1
6.	Germany, Federal	C	45.2	47.4	49.5	51.7	53.8
	Republic of	R	81.4	85.2	89.1	93.0	96.9
7.	France	C	40.9	43.1	45.2	47.4	49.5
		R	77.1	80.9	84.8	88.7	92.6
8.	United Kingdom	C	40.9	43.1	45.2	47.4	49.5
		R	72.3	75.8	79.2	82.7	86.1
9-14.	Northern Europe I	C	40.9	43.1	45.2	47.4	49.5
		R	77.1	80.9	84.8	88.7	92.6
15-18.	Northern Europe II	C	36.2	37.9	39.6	41.3	43.1
		R	68.0	71.5	74.9	78.4	81.8
19.	Italy	C	36.2	37.9	39.6	41.3	43.1
		R	68.0	71.5	74.9	78.4	81.8
20-25.	Southern Europe	C	31.9	33.6	35.3	37.0	38.7
		R	54.2	56.8	59.4	62.0	64.6
26-32.	Eastern Europe	C	36.2	37.9	39.6	41.3	43.1
		R	68.0	71.5	74.9	78.4	81.8
33-58.	Rest of the world	C	36.2	37.9	39.6	41.3	43.1
		R	59.0	62.0	65.0	68.0	71.0

Notes: C = Conventional tires
R = Radial tires

Table 5.4. Projections of demand for passenger cars tires (in thousands) for the standard scenario G1

Notes: NC = new convential tires
NR = new radial tires
RT = remoulded tires
TT = total tires

		Code	1985	1990	1995	2000
I.	North America	NC	27348.	8053.	0.	0.
		NR	149214.	165588.	161639.	154308.
		RT	23828.	26538.	31209.	36111.
		TT	200390.	200179.	192847.	190419.
II.	Asia, developed	NC	3297.	1065.	0.	0.
		NR	26025.	31120.	31431.	29437.
		RT	5181.	6391.	7364.	7346.
		TT	34504.	38577.	38795.	36783.
III.	Oceania, developed	NC	2206.	560.	0.	0.
		NR	9166.	11059.	11499.	11462.
		RT	943.	1326.	1728.	1713.
		TT	12316.	12945.	13227.	13174.
IV.	North-West Europe	NC	2907.	0.	0.	0.
		NR	85901.	81220.	73848.	66315.
		RT	8538.	9476.	10289.	10102.
		TT	97346.	90696.	84136.	76417.
V.	South-West Europe	NC	725.	0.	0.	0.
		NR	37010.	37405.	36422.	35800.
		RT	4127.	5141.	6211.	7511.
		TT	41863.	42546.	42633.	43311.
VI.	Eastern Europe	NC	10574.	5860.	3294.	1883.
		NR	16510.	24386.	30913.	37263.
		RT	2598.	3793.	5753.	6356.
		TT	29682.	34039.	39960.	45501.
VII.	Latin America + Caribbean	NC	17803.	10868.	6652.	3953.
		NR	27860.	45227.	62335.	78219.
		RT	2696.	2635.	5749.	9984.
		TT	48359.	58730.	74736.	92155.
IX.	South Asia	NC	2941.	2408.	2254.	1713.
		NR	2008.	3761.	5345.	7137.
		RT	149.	348.	522.	782.
		TT	5098.	6517.	8121.	9632.
X.	South-East + East Asia	NC	3072.	1475.	1081.	0.
		NR	7334.	13786.	20840.	32251.
		RT	229.	623.	1286.	2304.
		TT	10635.	15884.	23207.	34555.
XI.	Middle East + North Africa	NC	2469.	916.	507.	0.
		NR	5900.	8579.	9798.	11391.
		RT	192.	407.	661.	891.
		TT	8561.	9903.	10966.	12281.
XII.	Other Africa	NC	10685.	8243.	7356.	5443.
		NR	7303.	12904.	17452.	22696.
		RT	569.	1242.	1762.	2543.
		TT	18556.	22393.	26570.	30682.
World total (excl. Asian CPE countries)		NC	34028.	39452.	21146.	12992.
		NR	374232.	435036.	461519.	486278.
		RT	49049.	57921.	72533.	85642.
		TT	507309.	532410.	555197.	584912.

Table 5.5 Projections of demand for commercial vehicles tires (in thousands) for the standard scenario G1

Notes: NC = new conventional tires
NR = new radial tires
RT = remoulded tires
TT = total tires

	Code	1985	1990	1995	2000
I. North America	NC	9427.	2709.	0.	0.
	NR	41805.	53734.	54157.	51098.
	RT	18754.	19201.	21978.	25582.
	TT	69986.	75643.	76135.	76680.
II. Asia, developed	NC	5670.	2499.	1200.	0.
	NR	20451.	29212.	35225.	41753.
	RT	6701.	7886.	10169.	12824.
	TT	32822.	39597.	46594.	54579.
III. Oceania, developed	NC	787.	263.	137.	0.
	NR	2137.	2656.	2720.	2830.
	RT	984.	924.	1017.	1168.
	TT	3908.	3843.	3873.	3998.
IV. North-West Europe	NC	493.	0.	0.	0.
	NR	14543.	15300.	15726.	16625.
	RT	4478.	4946.	5785.	5983.
	TT	19514.	20246.	21511.	22608.
V. South-West Europe	NC	731.	225.	0.	0.
	NR	5906.	6729.	7030.	7515.
	RT	2846.	3012.	3443.	3617.
	TT	9547.	9965.	10473.	11131.
VI. Eastern Europe	NC	6256.	3627.	1954.	647.
	NR	7198.	9750.	11564.	12916.
	RT	4707.	4451.	4704.	5031.
	TT	18161.	18027.	18222.	18495.
VII. Latin America + Caribbean	NC	6217.	4614.	2112.	777.
	NR	7461.	10681.	13671.	16127.
	RT	1866.	1516.	2307.	2932.
	TT	15544.	16810.	18089.	19836.
IX. South Asia	NC	1541.	1196.	1092.	623.
	NR	1118.	1948.	2652.	3556.
	RT	250.	358.	483.	598.
	TT	2909.	3502.	4231.	4777.
X. South-East + East Asia	NC	1956.	1198.	734.	453.
	NR	3273.	5169.	6861.	9287.
	RT	356.	565.	865.	1113.
	TT	5585.	6932.	8460.	10853.
XI. Middle East + North Africa	NC	910.	462.	249.	134.
	NR	1483.	2094.	2326.	2752.
	RT	176.	234.	314.	349.
	TT	2569.	2790.	2889.	3235.
XII. Other Africa	NC	4516.	3553.	3271.	2468.
	NR	3297.	5790.	7943.	10598.
	RT	710.	1050.	1463.	1756.
	TT	8523.	10393.	12677.	14822.
World total (excl. Asian CPE countries)	NC	38559.	19972.	10748.	5301.
	NR	109655.	143040.	159873.	175070.
	RT	41831.	44442.	52531.	60943.
	TT	190045.	207454.	223152.	241314.

Table 5.6 Percentage share of replacement tires (incl. retreads) for passenger cars in total tires

	1985	1990	1995	2000
I. North America	71.7	66.2	66.1	64.3
II. Asia, developed	46.9	44.8	45.2	42.5
III. Oceania, developed	69.6	67.2	65.3	65.0
IV. North-West Europe	57.0	52.2	48.9	44.1
V. South-West Europe	64.8	60.4	58.3	57.8
VI. Eastern Europe	72.9	69.6	70.2	69.0
VII. Latin America + Caribbean	79.6	74.8	73.3	71.0
IX. South Asia	76.9	76.4	74.7	73.8
X. South-East + East Asia	74.2	71.3	68.4	66.7
XI. Middle East + North Africa	77.2	74.8	74.4	72.5
XII. Other Africa	80.7	79.2	77.1	75.4
World total (excl. Asian CPE countries)	67.9	64.0	63.6	62.3

Table 5.7 Percentage share of replacement tires (incl. retreads) for commercial vehicles in total tires

		1985	1990	1995	2000
I.	North America	72.4	63.1	64.1	66.7
II.	Asia, developed	55.2	49.2	48.5	47.0
III.	Oceania, developed	73.0	66.7	65.2	64.9
IV.	North-West Europe	56.9	54.3	53.8	52.9
V.	South-West Europe	72.0	66.9	65.7	65.0
VI.	Eastern Europe	69.1	65.0	63.4	60.1
VII.	Latin America + Caribbean	80.0	75.9	73.9	72.1
IX.	South Asia	78.0	73.1	69.9	69.5
X.	South-East + East Asia	73.9	68.0	65.9	66.2
XI.	Middle East + North Africa	76.1	69.6	70.1	69.6
XII.	Other Africa	75.3	72.2	69.9	69.2
World total (excl. Asian CPE countries)		68.4	61.9	61.3	61.0

6. Rubber demand in the non-tire sector and in the tire sector and total rubber demand

6.1 Non-tire rubber demand

As was stated in chapter 1, specific non-tire end-uses for rubber number in the thousands. To mention a few: rubber thread, rubberised cloth, footwear, window strips, engine mouldings, conveyor belts, hoses, rubber sheets, roofing sheets, rubber gloves, carpet backing, elastic rubber bands, fishing ropes and soft-balls. It goes without saying that availability of data, manpower and time are barriers to doing any kind of detailed analysis.

Even if these constraints were not relevant, the next barrier would be the availability of information about the rubber content of the various products. It is quite impossible to determine the rubber content of such a thing as the average conveyor belt. First,even conveyor belts can be found in many different types and, second, the mix of materials prevent the researcher from singling out the rubber contents.

A way out is to focus on the countries where the rubber products are produced, because it is there where disappearance of rubber might be traced. Reducing the number of end-uses by concentrating on broad categories, one might come up with an analysis of the composition of rubber consumption as reflected in table 6.1 for the case of Japan.

Table 6.1 Composition of rubber consumption by broad non-tire end-uses in Japan, percentages.

	1961	1964	1967	1970	1973
Rubber footwear	34	34	26	18	11
Belting	10	10	11	11	7
Hose	5	4	4	4	4
Rubberised cloth	6	5	4	3	3
Industrial and latex products	16	10	35	31	33
Wire and cable	5	6	4	3	4
Miscellaneous	24	31	16	30	38

Source: Rubber Statistical Bulletin.

One may draw a few conclusions from this table.
The relative contribution of footwear to total rubber consumption has declined dramatically. The major reason for this is increased competition from such low-wage countries as Korea and Taiwan. Next, there is a tendency for developed countries to produce goods which require a high level of technology: industrial products and miscellaneous. Finally, many products, which were end-uses of rubber in the past, are now made of plastic. Concluding: products disappear from the rubber scene and new ones emerge. This strongly complicates the analysis, because, even if one might be able to forecast disappearance of an end-use, it is quite impossible to accurately predict which new end-uses may come to the fore.

Looking at rubber-consumption by non-tire end-uses as a whole, it is very interesting to see that there is a very smooth pattern and that total non-tire rubber consumption can be very well related to total production of the country concerned. Data permit to do this analysis for seven (groups of) countries: United States and Canada, Japan, West-Germany, France, the United Kingdom, Italy and Brazil. Since for these countries rubber consumption in the non-tire sector has been about 40 % of total rubber consumption all through the sixties and the seventies (cf. table A.4), and assuming the same percentage for the rest of the world, the relationship between non-tire rubber consumption and GDP can be determined.

Projections of rubber consumption may now be derived by basing calculations on the three GDP-scenarios, presented in chapter 2. Results are given in table 6.2.

Table 6.2 Projections of non-tire rubber consumption (in thousand tons)

		1985	1990	1995	2000
United States + Canada	G1	1,438	1,628	1,835	1,989
	G2	1,575	1,978	2,448	2,903
	G3	1,673	2,238	2,929	3,666
Japan	G1	619	798	1,022	1,267
	G2	651	908	1,253	1,672
	G3	680	999	1,445	2,021
Germany, Fed.Rep.	G1	432	533	654	775
	G2	456	612	811	1,037
	G3	478	676	942	1,264
France	G1	182	218	259	299
	G2	191	248	320	398
	G3	200	275	371	485
United Kingdom	G1	246	271	298	316
	G2	266	320	382	442
	G3	280	356	449	546
Italy	G1	266	322	387	449
	G2	282	372	485	609
	G3	296	414	567	748
Brazil	G1	174	239	324	425
	G2	183	272	398	559
	G3	191	300	459	675
Rest of the World (excl. Asian CPEC)	G1	2,734	3,292	3,988	4,744
	G2	2,855	3,692	4,803	6,137
	G3	2,964	4,018	5,478	7,339
World total (excl. Asian CPEC)	G1	6,090	7,302	8,766	10,264
	G2	6,459	8,403	10,899	13,757
	G3	6,762	9,274	12,640	16,744

6.2 Rubber demand in the tire sector

6.2.1 Rubber demand for passenger car tires

Deriving rubber demand for passenger car tires from the number of tires presented in the previous chapter, is a rather straightforward exercise: multiplying tires and their respective rubber contents. Some questions need to be answered:
- what is the average rubber content of a passenger car tire;
- what is the difference between conventional tires and radial tires;
- is a change in rubber content to be anticipated;
- what is the reduction in elastomer use of retreading a tire?

A major problem in this exercise is to derive good estimates of the weight of the elastomer content in different types of tires. Scattered information is available in published and unpublished sources showing elastomer content in various types of tires by country and over time. These statistics indicate that there is considerable variation among countries but not much variation over time except for such countries as the USA in recent years. We used these sources to obtain estimates for passenger car tires in the major countries, including the United States, Japan and certain EEC countries. These estimates vary by country depending on the average size of passenger cars. For countries or regions for which no adequate information has been obtained, elastomer weight per tire has been estimated by assessing average car size. As additional information, radial tires have been estimated to contain 10 per cent more rubber per tire than conventional tires. The estimation results on elastomer weight are presented in table 6.3. A small decrease is anticipated for the USA, Canada and Australia and New Zealand because of a reduction in car size.

Elastomer content of remoulded tires has to be dealt with separately since these tires absorb far less (new) rubber. The reduction in elastomer use has been estimated at 55 per cent, based on various statistical sources and discussions with experts.

The results of the multiplication of numbers of tires and their respective elastomer weights are presented in table 6.4 for scenario a and in table A.43 for all scenarios.

Table 6.3 Elastomer weights of passenger car tires (in kg).

			1980	1985	1990	1995	2000
1.	United States	C	6.0	5.9	5.8	5.7	5.6
		R	6.6	6.5	6.4	6.3	6.2
2.	Canada	C	5.9	5.8	5.7	5.6	5.4
		R	6.5	6.4	6.3	6.2	6.0
3.	Japan	C	4.6	4.6	4.6	4.6	4.6
		R	5.1	5.1	5.1	5.1	5.1
4-5.	Oceania	C	5.9	5.8	5.7	5.6	5.4
		R	6.5	6.4	6.3	6.1	6.0
6.	Germany,Federal	C	5.3	5.3	5.3	5.3	5.3
	Republic of	R	5.8	5.8	5.8	5.8	5.8
7.	France	C	5.2	5.2	5.2	5.2	5.2
		R	5.7	5.7	5.7	5.7	5.7
8.	United Kingdom	C	5.2	5.2	5.2	5.2	5.2
		R	5.7	5.7	5.7	5.7	5.7
9-14.	Northern Europe I	C	5.2	5.2	5.2	5.2	5.2
		R	5.7	5.7	5.7	5.7	5.7
15-18.	Northern Europe II	C	5.1	5.1	5.1	5.1	5.1
		R	5.6	5.6	5.6	5.6	5.6
19.	Italy	C	5.0	5.0	5.0	5.0	5.0
		R	5.5	5.5	5.5	5.5	5.5
20-25.	Southern Europe	C	4.9	4.9	4.9	4.9	4.9
		R	5.3	5.3	5.3	5.3	5.3
26-32.	Eastern Europe	C	4.6	4.6	4.6	4.6	4.6
		R	5.1	5.1	5.1	5.1	5.1
33-58	Rest of the world	C	4.6	4.6	4.6	4.6	4.6
		R	5.1	5.1	5.1	5.1	5.1

Notes: C = Conventional tires
R = Radial tires

Table 6.4 Projections of rubber demand for passenger car tires (in thousand tons) for the standard scenario G1

		1985	1990	1995	2000
I.	North America	1194.	1175.	1098.	1048.
II.	Asia, developed	160.	179.	178.	167.
III.	Oceania, developed	74.	76.	75.	74.
IV.	North-West Europe	530.	490.	450.	406.
V.	South-West Europe	214.	215.	212.	212.
VI.	Eastern Europe	139.	160.	186.	214.
VII.	Latin America + Caribbean	231.	287.	362.	441.
IX.	South Asia	24.	31.	39.	46.
X.	South-East + East Asia	52.	79.	114.	170.
XI.	Middle East + North Africa	42.	49.	54.	60.
XII.	Other Africa	88.	107.	127.	147.
World total (excl. Asian CPE countries)		2748.	2848.	2896.	2984.

6.2.2. Rubber demand for commercial vehicle tires

The determination of rubber demand for commercial vehicle tires follows the same system as in the case of passenger car tires. The same problems are encountered as well.

Elastomer weight estimates of commercial vehicle tires, however, are even more difficult to obtain. About half of commercial vehicles use big passenger car tires. The rest differ considerably, depending on vehicle size. Information for some countries for some sizes of commercial vehicle tires has been obtained. Using weighted averages and introducing some adjustments we arrived at the figures presented in table 6.5. Countries and regions for which no information was available were treated in the same way as in the case of passenger car tires.

Afterwards rubber demand for commercial vehicle tires may be calculated. Results are shown in table 6.6 for scenario G1 only and in table A.44 for all scenarios.

Table 6.5 Elastomer weight of commercial vehicle tires (in kg).

			1980-2000
1.	United States	C	22.6
		R	24.9
2.	Canada	C	22.6
		R	24.9
3.	Japan	C	13.6
		R	14.7
4-5.	Oceania	C	22.6
		R	24.9
6.	Germany, Federal	C	27.1
	Republic of	R	29.9
7.	France	C	24.9
		R	27.1
8.	United Kingdom	C	23.7
		R	26.0
9-14.	Northern Europe I	C	26.0
		R	28.3
15-18.	Northern Europe II	C	23.7
		R	26.0
19.	Italy	C	22.6
		R	24.9
20-25	Southern Europe	C	20.3
		R	22.6
26-32.	Eastern Europe	C	22.6
		R	24.9
33-36.	Latin America	C	13.6
		R	14.7
39-43.	S. Asia	C	12.4
		R	13.6
44-52.	E. + S.E. Asia	C	13.6
		R	14.7
53-54.	Middle East +	C	14.7
	N. Africa (oil)	R	15.8
55-58.	Other Middle East +	C	12.4
	Africa	R	14.7

Notes: C = Conventional tires
R = Radial tires

Table 6.6 Projections of rubber demand for commercial vehicle tires (in thousand tons) for the standard scenario G1

		1985	1990	1995	2000
I.	North America	1458.	1611.	1592.	1556.
II.	Asia, developed	421.	515.	601.	698.
III.	Oceania, developed	82.	82.	82.	83.
IV.	North-West Europe	467.	482.	504.	531.
V.	South-West Europe	184.	193.	200.	214.
VI.	Eastern Europe	370.	377.	383.	389.
VII.	Latin America + Caribbean	205.	223.	244.	267.
IX.	South Asia	36.	43.	52.	62.
X.	South-East + East Asia	76.	96.	116.	150
XI.	Middle East + North Africa	38.	42.	43.	48.
XII.	Other Africa	109.	135.	166.	199.
World total (excl. Asian CPE countries)		3445.	3799.	3985.	4198.

6.2.3 Rubber demand for other tires

Thusfar, rubber demand has been derived and projected for passenger car tires and commercial vehicle tires. This leaves untreated those groups of tires (and tubes) used for tractors, airplanes, motorcycles, scooters and bicycles. They may be estimated at about 6 % of world rubber consumption in 1975. We relate this end-use to GDP on a world scale (excl. Asian Centrally Planned Economies) and arrive at projections presented in table 6.7.

Table 6.7 World rubber demand (excl. Asian Centrally Planned Economies) for tires other than those for passenger cars and commercial vehicles (in metric tons), for three scenarios.

	scenario	1985	1990	1995	2000
Rubber demand	G1	1,075	1,290	1,545	1,810
	G2	1,140	1,485	1,925	2,430
	G3	1,195	1,635	2,230	2,955

6.2.4 Rubber demand in the tire sector

Having thus far excluded Asian Centrally Planned Economies, all components of rubber demand for tires have been projected. Simply adding up results in table 6.8.

Table 6.8 World rubber demand in the tire sector (in 1000 metric tons) for five scenarios

	scenario	1985	1990	1995	2000
World (excl. Asian CPE countries)	G1-a	7,268	7,937	8,426	8,992
	G2-b	7,696	8,940	10,136	11,599
	G2-c	7,732	9,042	10,263	11,738
	G3-d	8,103	9,818	11,660	14,016
	G3-e	8,139	9,918	11,792	14,158

6.3 World demand for rubber

In sections 6.1 and 6.2 world demand for rubber in the non-tire sector and the tire sector has been derived. Aggregating these two sectors by adding the totals of table 6.2 and table 6.8, world demand for rubber, excluding Asian Centrally Planned Economies is obtained. Results are shown in table 6.9.

Table 6.9 World rubber demand (in 1000 metric tons) for five scenarios.

	scenario	1985	1990	1995	2000
World (excl. Asian CPE-countries)	G1-a	13,358	15,239	17,192	19,256
	G2-b	14,155	17,343	21,035	25,356
	G2-c	14,191	17,445	21,162	25,495
	G3-d	14,865	19,092	24,300	30,760
	G3-e	14,901	19,192	24,432	30,902.

It is interesting to note that differences between scenarios b and c are minor, implying that scenarios for different saturation levels hardly affect future rubber consumption. On the other hand, different levels of economic growth will have an enormous impact on future rubber demand, as can be derived from results of different economic scenarios: G1, G2 and G3.

Thusfar no attention has been paid to the case of China (and the other Asian Centrally Planned Economies). It needs no further clarification that it is extremely difficult to obtain information on the structure of rubber consumption and its relationship to such indicators as income and production. In order to give some impression, we might calculate the effects of growth in GDP in China on rubber consumption, assuming an elasticity of 2.0, which presumably is as good a guesstimate as any other. Further basis for the analysis is estimated rubber consumption in 1980, amounting to 500 thousand metric tons. Results are presented in table 6.10.

Table 6.10 Estimated rubber demand in Asian Centrally Planned Economies (in thousand metric tons), for 3 economic scenarios (cf. chapter 2)

	scenario	1985	1990	1995	2000
Asian Centrally Planned Economies	G1	809	1,400	2,446	4,085
	G2	881	1,742	3,473	6,628
	G3	946	2,039	4,432	9,228

Combining tables 6.9 and 6.10 gives total world rubber demand for 1985, 1990, 1995 and 2000, as shown in table 6.11.

Table 6.11 Estimated world rubber demand (in thousand metric tons) for five scenarios

	scenario	1985	1990	1995	2000
Total world	G1-a	14,167	16,639	19,638	23,341
	G2-b	15,036	19,085	24,508	31,984
	G2-c	15,073	19,186	24,635	32,123
	G3-d	15,811	21,131	28,732	39,988
	G3-e	15,847	21,231	28,864	40,130

Chapter 7. NR versus SR: Demand and Supply - Some tentative conclusions

In this chapter a review of supply projections will be given for natural rubber (hevea), Guayule and synthetic rubber. Afterwards a preliminary division of total demand for rubber into NR and SR will be presented. Finally, in a confrontation between the above, the prospective supply-demand position for NR and SR will be assessed.

7.1 Review of rubber supply

7.1.1 Supply of NR (hevea)

Natural rubber (NR) can be detracted from numerous trees, plants, vines and shrubs. However, thusfar only Hevea Brasiliensis and Guayule have been commercially produced in any quantities anywhere. The subject of this section is the supply of the only viable economic natural rubber crop available to-date: Hevea rubber. Prospects for Guayule rubber will be discussed in the following section. Since this paper only tentatively deals with rubber supply and the report on part 2 of the study will elaborate on rubber supply, a brief review of supply prospects will suffice.

Natural rubber is produced in many tropical parts of countries all over the world. The centre of NR production is the South East Asian region. Malaysia, Indonesia and Thailand provided about 80 % of world NR production in 1979. Other important producers are Sri Lanka (4.0%), India (3.8 %), Liberia (1.9 %), Philippines (1.7 %) and Nigeria (1.4 %).

Supply projections for NR are themselves to some extent independent of future demand. As the share of NR in total demand is at present only 30 percent, whilst on technical considerations it could be much higher, a growth in NR supply outstripping growth of total demand is possible.This encroachment would lead to price competition between NR and SR. Future development of production costs of both NR and SR will determine whether the price level of NR, resulting from this price competition, provides sufficient incentive to expand NR capacity at a faster rate than the growth of total demand. This theme will be further developed in part 2 of our study. At present we shall confine ourselves to an inventory of supply projections by other groups and individuals, commenting on these projections and thus deriving a set of tentative projections of NR supply which we consider reasonably realistic.

In table 7.1 below, data and projections for five-year periods are presented. Projections are given as derived in:

p - 1 Planters' Bulletin of the Rubber Research Institute of Malaysia, Kuala Lumpur, September 1970.

p - 2 The Agro-Economic Norm of Natural Rubber Production, Association of Natural Rubber Producing Countries, Kuala Lumpur, October 1976.

p - 3 Proceedings of the 25th Assembly of the International Rubber Study Group, Washington D.C., June 1978.

p - 4 B.C. Sekhar, T.Y. Pee: Natural Rubber, potentials for the future, Malaysian Rubber Research and Development Board, Kuala Lumpur, 1979.

p - 5 Proceedings of the 92nd International Rubber Study Group Meeting, London, October 1979.

p - 6 Proceedings of 26th Assembly of the International Rubber Study Group, Kuala Lumpur, October 1980 (forthcoming).

p - 7 Projections as compiled by the author of this paper.

Below projections are evaluated country by country and three projections of production are derived based upon the authors judgement. These projections by means of "prospects" will be improved in the report in part 2 as has already been mentioned above. Three prospects per country will be developed, thus only indicating broad lines:

I. low levels of prospective production

II. medium levels of prospective production

III. high levels of prospective production.

Data and (average) projections as given in the above 6 publications are presented in figure 7.1 and 7.2. World totals and projections according to our three prospects are shown in figure 7.3.

Malaysia

A steep increase in production in the 1960s was the basis for a rather high forecast for 1980 in publication p.1, which was published in 1970. Projections, carried out in the second half of the 1970s were decreasingly optimistic but still rather much in line except p-6 as presented by P.O. Thomas in a paper for the 26th Assembly of the IRSG. Results of this latter set of projections, broadly show a continuation of the trend calculated as a straight line between production in 1960 and 1980. Major problems are:

- insufficient availability of labour which may require more labour extensive techniques to be introduced, resulting in a lower yield per hectare;
- improved technology which may increase flexibility in production rather than overall production levels;
- alternative crops like palm oils being still more economically attractive

It is as yet hard to predict whether improvements in clones and tapping methods and increase in smallholder area will offset these negative aspects and provide the basis for a continuing increase along the lines as were prevalent in the past decades.

The following prospects may be considered:
I. continuation of the trend since 1973;
II. projections which are slightly lower than these given by p-6;
III.projections which are slightly higher than p-6.
Results are given in table 7.1, on the lines for p-7.

Indonesia

As can be seen in table 7.1 and figure 7.1, the Agro-Economic Norm Study derived very optimistic projections for Indonesian rubber production in the 1980s. Even the low estimate for 1980 is more than 15 % too high, while the high estimate for 1980 is more than 30 % too high. Projections p-3, p-4 and p-5 are rather much in line, predicting a continuation of the current trend. However, a paper presented by the Indonesian delegation to the 26th Assembly of the International Rubber Study Group in October 1980, showed plans for huge levels of replanting and new planting in the 1980s, totaling more than 1,000,000 hectares. This should push production by 1990 to 1,700,000 tons. This target may coincide with our prospect III. Prospect I then may be defined as continuation of the current trend, and prospect II may be calculated as the average of I and III. Results are shown in table 7.1: p-7.

Thailand

Thailand is the only major natural rubber producing country where NR production predictions in the past have turned but to be lower then realization. Besides, including the Agro Economic Norm Study, all predictions are reasonably close together. In his paper for the 26th Assembly of the International Rubber Study Group, Slearmlarp Wasuwat gave two sets of predictions:
- trend: what can be achieved with existing development activities;
- potential: what will be produced if new development activities are implemented.

This latter set of projections seems suitable as our prospect III. The trend projections will be used as prospect II. In order to give room for a more pessimistic view, a set of projections is introduced as prospect I which is slightly lower than the above "trend".

Sri Lanka

For the last decade Sri Lanka's NR production has been constant, as can be derived from table 7.1 and figure 7.2. Projections, however, unanimously show an increase over the years to come. The following prospect may be used:

I. no increase: a constant level of 150,000 tons;

II. a small increase: 190,000 tons in 1990 and 230,000 tons in 2000;

III. a somewhat larger increase: 210,000 tons in 1990 and 300,000 tons in 2000.

Africa

Production of NR reached a top level of 230,000 tons in 1974 and declined afterwards to 188,000 tons in 1979. This is due to a decrease in production in that period of 33 % in Nigeria, 30 % in Liberia and 28 % in Zaire. However, projections of the International Rubber Study Group show an increase for the decade ahead. These might be used as prospect III. The other prospects then may be formulated as:

I. small decrease;

II. average of I and III;

III. the above mentioned IRSG projections.

Others

About one third of NR produced by countries in the category "Others" comes from India. Other major members of this group are Philippines, Vietnam and China. It is very hard to formulate scenarios. The following prospects might be acceptable:

I. starting from 450,000 tons in 1980, increasing 50,000 tons per 5 years;

II. ditto, increasing 100,000 tons;

III. ditto, increasing 150,000 tons.

World total

Total NR production for 5-year periods is shown in figure 7.3. The above defined three scenarios now may be derived by adding projections by country or region. Results are shown in table 7.1 and in figure 7.3 as well. A further evaluation will be appropriate when the supply-demand balance is discussed because the prospects I and III broadly depict the range of prospective NR supply for the world as a whole. Realization of these projections will depend on prospective demand as well.

Table 7.1 Production of natural rubber in thousand metric tons.

Country, region	d/p code	last observation	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
Malaysia	d		700	785	917	1,269	1,459					
	p - 1	1969						2,100				
	p - 2 low	1974						1,880	1,985	2,050		
	high							2,335	2,520	2,665		
	average							2,110	2,255	2,360		
	p - 3	1977						1,950	2,250	2,750		
	p - 4	1978						2,000	2,400	2,700		
	p - 5	1978						1,750	2,250	2,750		
	p - 6	1979							1,850	2,000		2,500
	p - 7 I	1979							1,700	1,800	1,900	2,000
	II								1,800	1,950	2,125	2,300
	III								1,900	2,100	2,350	2,600
Indonesia	d		749	620	716	815	823					
	p - 2 low	1974						1,080	1,410	1,800		
	high							1,210	1,600	2,150		
	average							1,145	1,505	1,975		
	p - 3	1977						950	1,050	1,175		
	p - 4	1978						920	1,010	1,100		
	p - 5	1978						950	1,050	1,175		
	p - 6	1979							1,000	1,700		
	p - 7 I	1979							1,000	1,150	1,250	1,350
	II								1,000	1,425	1,625	1,775
	III								1,000	1,700	2,000	2,200

Table 7.1 (cont. 1) Production of natural rubber in thousand metric tons.

Country, region	d/p code	last observation	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
Thailand	d		132	171	216	287	335					
	p - 2 low	1974						475	645	950		
	high							550	800	1,150		
	average							515	725	1,050		
	p - 3	1977						500	600	825		
	p - 4	1978						540	785	1,140		
	p - 5	1978						540	750	1,000		
	p - 6 trend	1979						585	907	1,289	1,677	1,849
	potential							585	947	1,405	2,012	2,264
	average							585	927	1,347	1,845	2,057
	p - 7 I	1979							800	1,100	1,350	1,550
	II								905	1,290	1,675	1,850
	III								945	1,405	2,010	2,265
Sri Lanka	d		94	99	118	159	149					
	p - 2 low	1974						180	190	170		
	high							205	230	220		
	average							195	210	195		
	p - 3	1977						170	190	215		
	p - 4	1978						180	185	195		
	p - 5	1978						165	185	200		
	p - 7 I	1979							150	150	150	150
	II								165	180	195	210
	III								180	210	260	300

Table 7.1 (cont. 2) Production of natural rubber in thousand metric tons.

Country, region	d/p code	last observation	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
Africa	d		100	137	159	213	218					
	p - 3	1977						255	310	360		
	p - 5	1978						225	300	350		
	p - 7 I	1979							185	180	175	170
	II								245	265	290	310
	III								300	350	400	450
Others	d		185	204	219	200	285					
	p - 3	1977						440	500	575		
	p - 5	1978						415	500	600		
	p - 7 I	1979							500	550	600	650
	II								550	650	750	850
	III								600	750	900	1,050
World Total	d		1,950	1,990	2,353	3,103	3,315					
	p - 3	1977						4,250	4,900	5,900		
	p - 4	1978						4,350	5,245	6,135		
	p - 5	1978						4,000	5,000	6,000		
	p - 7 I	1979							4,335	4,930	5,425	5,870
	II								4,665	5,760	6,660	7,295
	III								4,925	6,215	7,920	8,865

d = data

p - 1 to p - 6 refer to projections as mentioned in the text.

p - 7: scenarios for prospective production (see text).

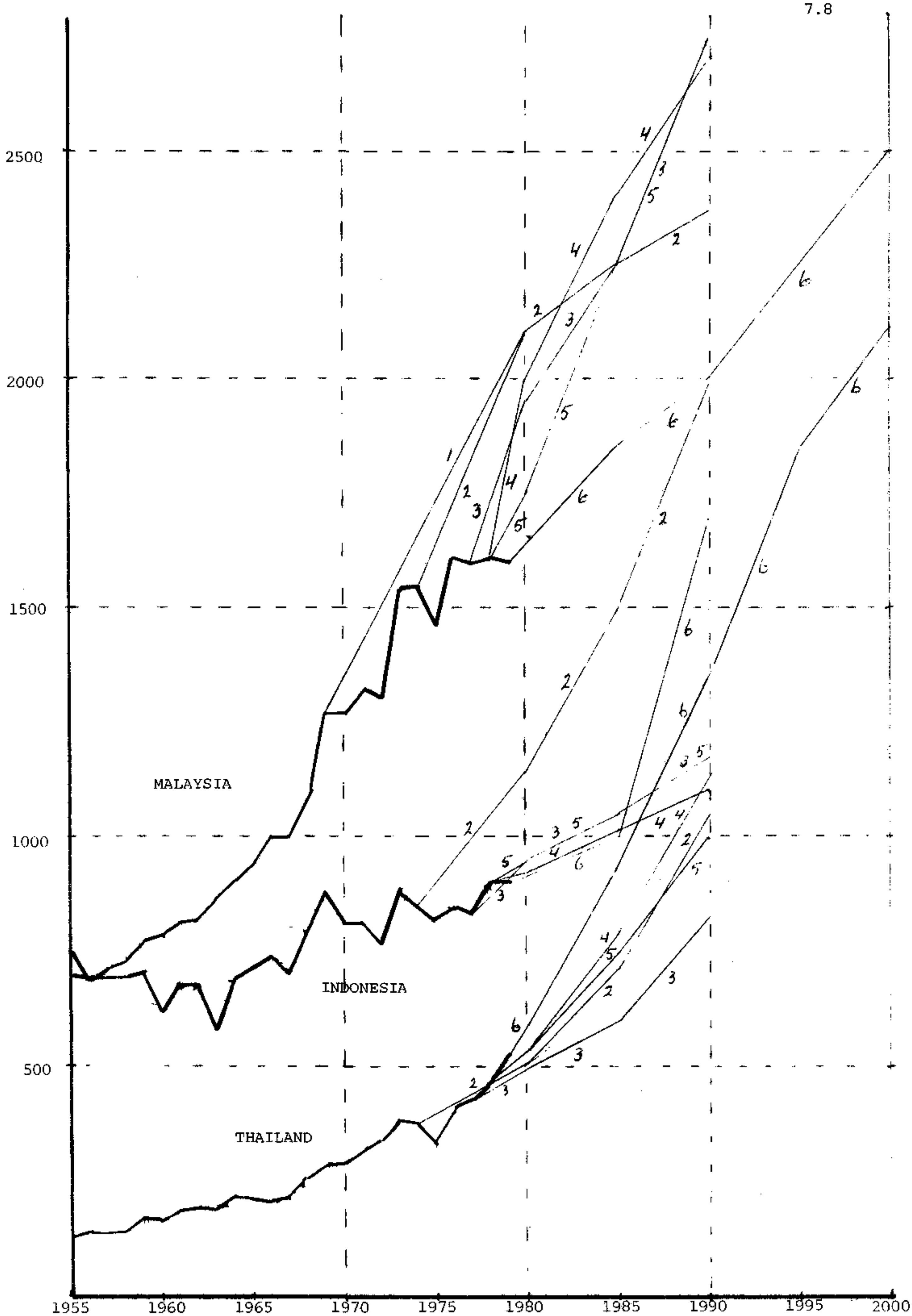


Figure 1. NR production (for explanation see figure 7.2).

7.9

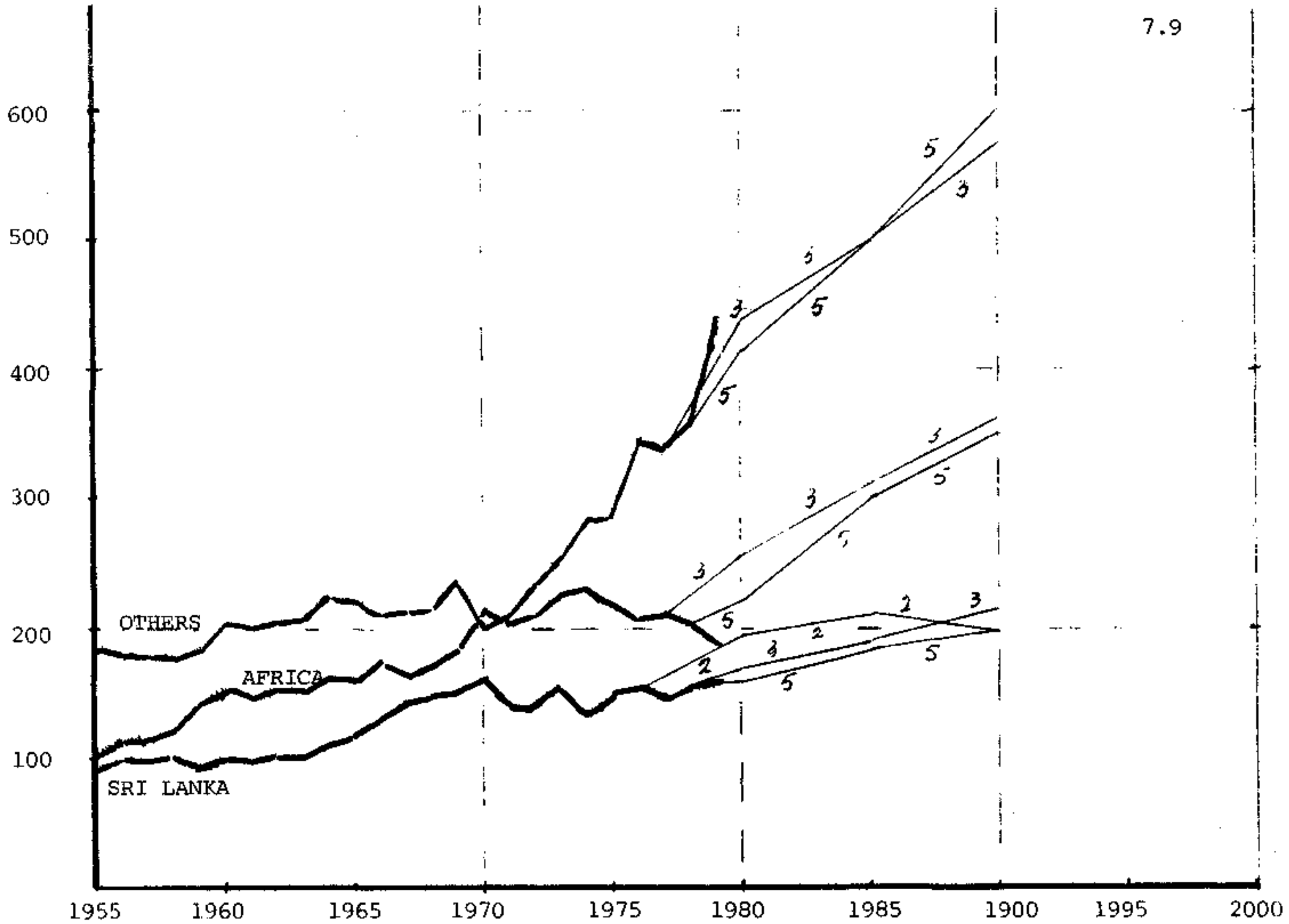


Figure 7.2 NR production by country or region in 1,000 metric tons: data (•) and projections (-); for projections, figures 1 to 6 refer to publications mentioned in the text; 7-I, 7-II, 7-III refer to derived scenarios.

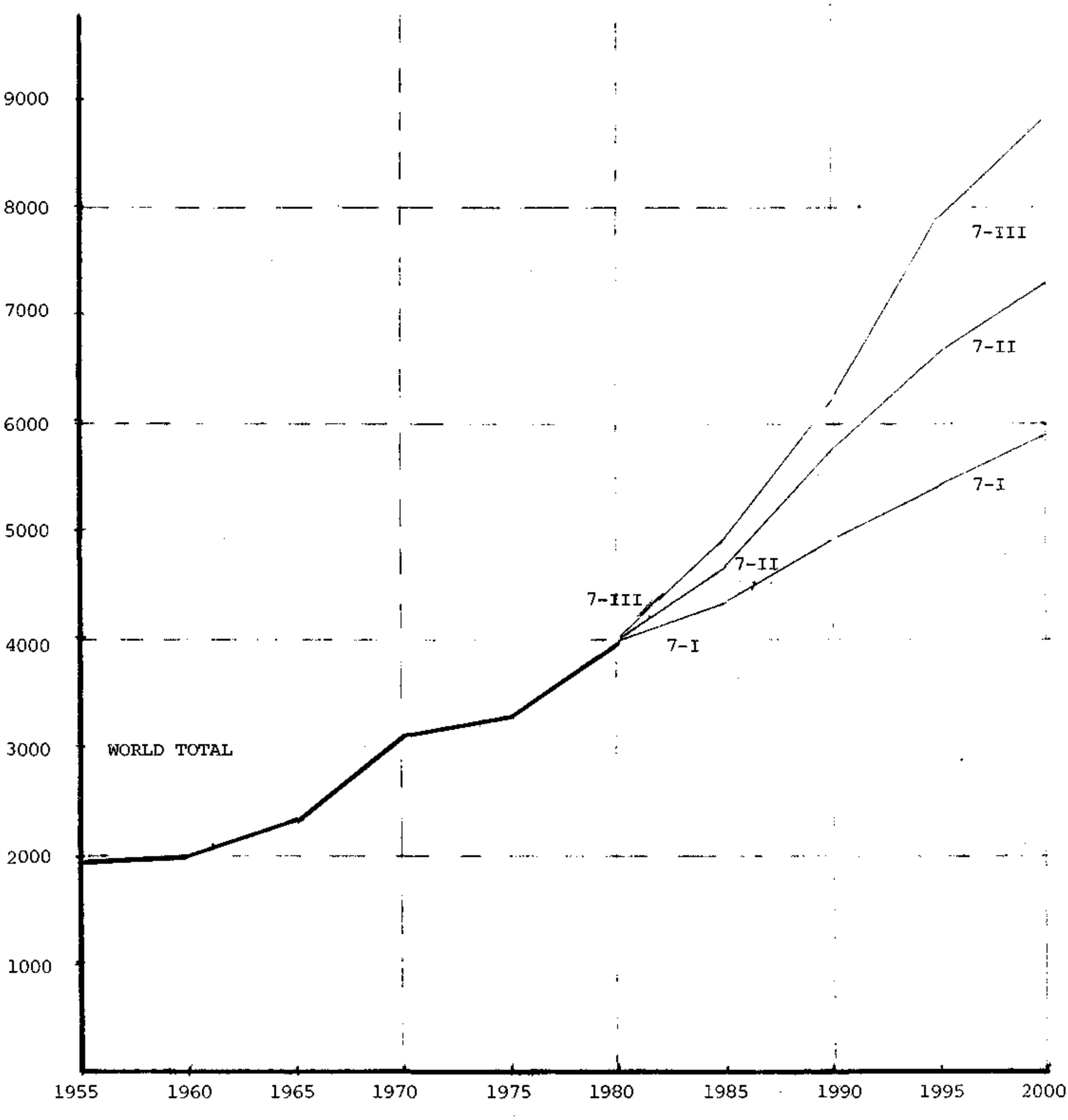


Figure 7.3 NR-production (for explanation see figure 7.2).

7.1.2 Guayule rubber

Guayule is a bushy perennial crop with an elaborate system of roots, allowing it to grow in rather dry areas. The plant grows best in well drained soils. Rubber constitutes 10 - 25 % of the total (dry) weight of the plant, depending on the type. About two-third of the rubber is found in the stems and branches and about one-third in the roots.

Rubber is obtained by either harvesting the plant including the roots, or by mowing off the bushes about 5 cm. above the ground. Most roots resprout and grow into new shrubs so fast that a thus developed one year old bush becomes as large as a two-year old seedling; in this way two crops are rapidly produced while avoiding the expensive replanting with seedlings normally required. It is unknown whether more than two crops can be produced in this way.

In the early part of this century Guayule,only growing in Mexico(and some Southern parts of the USA), accounted for some 10 % of total world rubber production and some 50 % of total US rubber consumption. In the 1920s Guayule was almost ousted because quantities of relatively cheap Hevea came on the market. To assure supply of rubber during the Second World War, many Guayule plantations were set up during that period. Total production then amounted some 5 thousand tons per year as a maximum. In the 1950s Guayule was outclassed by synthetic rubber.

After the oil crisis in 1973-74, a strong resurgence of interest and activity concerning Guayule appeared. Following an International Conference on the Utilization of Guayule in November 1975, the USA National Academy of Science set up a Panel of Senior Scientists to examine Guayule as an alternative source of natural rubber. Important conclusions of the Panel from the point of view of this study were:

- Guayule rubber and Hevea rubber have chemical and physical properties that are virtually identical;
- new agricultural techniques and extraction methods need to be developed if the plant is to be a commercially viable crop;
- Guayule has potential to become important to the USA's economy and security;
- Guayule cultivation might help less developed groups or countries, also in other parts of the world, to provide a living under dessert conditions.

To the 26th International Rubber Study Group Assembly, a report was presented concerning the Third International Guayule Conference in California in April 1980. It might be concluded that research on plant quality and cultivation condition is going on very well. Further it has been calculated that production of Guayule rubber is commercially viable if Hevea rubber prices are over US $ 1.60 per kg, which is slightly higher than the prevailing Hevea rubber price. Still, problems come to the fore in the area of harvesting and processing. In view of the nature of the cropping method, large scale industry seems most appropriate, whereas some additional production might be in the smallholder sector. Efforts, made so far, to get such an industry going are marginal and seem to reflect the feeling that Guayule rubber production should only get started on a larger scale if circumstances really required it. Otherwise substantial Guayule rubber production does not seem likely in the current century.

7.1.3 Production of synthetic rubber

Large scale production of synthetic rubber (SR) emerged when, during the Second World War, supply of NR was insufficient, largely because of blocked supply lines. In the fifties and sixties production of SR increased dramatically because demand for elastomers, particularly in the automotive sector, grew much faster than supply of NR, thus creating a reduction in the share of NR in total demand from 64 % in 1955 to some 30 % in the late seventies. This was feasible owing to technological improvements in SR, enabling SR to take over from NR.

Some synthetic rubbers have properties which are essential, or highly preferable, for some end uses. A large part of SR, however, the general purpose synthetic rubbers, is in direct competition with NR for important end uses. A surplus of NR and SR capacity to cover this type of demand will lead to a price decline for both types. In the past, this did not reduce current NR production, but led to idle capacity in the SR sector. In contrast to expansion of NR capacity, SR capacity takes only a few years to increase. Planning SR investment therefore has to take into account the projected overall demand for general purpose rubbers, and the projected supply of NR. It is therefore more inappropriate to make separate production projections for SR than it is for NR, without taking into account developments in demand. Some further remarks on this subject will be made in the next section. More elaborate attention to supply-demand interaction of NR and SR will be paid in the coming paper on part 2.

7.2 Tentative division of total rubber demand into NR and SR

In section 7.1, it has been stated that the share of NR in total demand, which is at present only 30 %, could be much higher on technical considerations. Whether this share may increase in future or on the contrary may decrease will depend on prices, production costs and availability as well. This theme will be elaborately analyzed in part II of the demand supply analysis of rubber.

In this section some calculations will be made, with a major focus on availability of NR. We shall begin to assume that the current share of NR per end-use per region will not change until the year 2000. It will later become clear that this assumption is thoroughly irrealistic. On the basis of this assumption "projections of NR demand" can be calculated, which then can be compared with supply projections of NR as developed in section 7.1. It cannot be sufficiently emphasized that the following sub-sections do not provide projections, but only give calculations in order to obtain a preliminary picture of prospective availability of NR in relation to demand.

7.2.1 NR-demand in the non-tire sector

In section 6.1, table 6.2, projections of non-tire rubber consumption have been presented. Using current NR-shares per region, it has been calculated what NR-demand for these end-uses would be if these NR-shares were to reamin constant. Current NR-shares are defined here as the average share of NR during 1977-1979 and are presented in table 7.2.

Table 7.2 Average NR-share in the non-tire sector per region (percentage) during 1977-1979

	share
USA + Canada*)	14.3
Japan	23.1
Germany, Fed.Rep.	18.2
France	21.2
United Kingdom	23.6
Italy	23.8
Brazil	15.5
Rest of the World (excl. Asian CPE countries)	27.0

*) 1977-1978 only

Subsequently "projections" of NR-demand are derived and presented in table 7.3.

Table 7.3 Projections of NR-demand in the non-tire sector (in thousand tons)

		1985	1990	1995	2000
United States + Canada	G1	206	233	262	284
	G2	225	283	350	415
	G3	239	320	419	524
Japan	G1	143	184	236	293
	G2	150	210	289	386
	G3	157	231	334	467
Germany, Fed.Rep.	G1	79	97	119	141
	G2	83	111	148	189
	G3	87	123	171	230
France	G1	39	46	55	63
	G2	40	53	68	85
	G3	42	58	79	103
United Kingdom	G1	58	64	70	75
	G2	63	76	90	104
	G3	66	84	106	129
Italy	G1	63	77	92	107
	G2	67	89	115	145
	G3	70	98	135	178
Brazil	G1	27	37	50	66
	G2	28	42	62	87
	G3	30	47	71	105
Rest of the World	G1	738	889	1077	1281
(Excl. Asian CPEC)	G2	771	997	1297	1657
	G3	800	1085	1479	1982
World total	G1	1353	1627	1961	2310
(excl. Asian CPEC)	G2	1427	1861	2419	3068
	G3	1491	2047	2794	3718

7.2.2 NR-demand in the tire sector

Similarly to the non-tire case in 7.2.1 NR-demand is obtained by estimating the current NR-share per tire per region and multiplying this with total rubber required for that type of tire in that particular region. Estimated percentage NR-shares are presented in table 7.4. It has further been assumed that retreading of tire does not require NR as virtually all NR goes into side-walls. "Projections" of NR-demand per region are presented in table A.45 for passenger car tires and A.46 for commercial vehicle tires. World totals, excluding Asian Centrally Planned Economy Countries are given in table 7.5. For other tires, the NR-share has been estimated at 35 %. "Projection" results are also shown in table 7.5.

Table 7.4 Estimated NR-share for tires (percentage)

			NR-share	
			passenger car tires	commercial vehicle tires
1.	United States	C	13	28
		R	34	63
2.	Canada	C	13	28
		R	34	63
3.	Japan	C	17	43
		R	39	63
4-5.	Oceania	C	17	43
		R	39	63
6.	Germany, Fed.Rep.	C	17	43
		R	39	63
7.	France	C	17	43
		R	39	63
8.	United Kingdom	C	17	43
		R	39	63
9-10.	Northern Europe I	C	17	43
		R	39	63
15-18.	Northern Europe II	C	17	43
		R	39	63
19.	Italy	C	17	43
		R	39	63
20-25.	Southern Europe	C	17	43
		R	39	63
26-32.	Eastern Europe	C	11	18
		R	34	48
33-36.	Latin America	C	11	18
		R	34	48
39-43.	S.Asian	C	34	53
		R	74	78
44-52.	E. + S.E. Asia	C	39	53
		R	84	83
53-54.	Middle East + N.Africa (oil)	C	13	23
		R	34	58
55-58.	Other Middle East + Africa	C	21	18
		R	59	73

Notes: C = conventional tires
R = radial tires

Table 7.5 Projections of world NR-demand in the tire sector (in thousand tons), excl. Asian CPEC

	scenario	1985	1990	1995	2000
Passenger car tires	G1-a	887	987	1,035	1,097
	G2-b	922	1,058	1,155	1,293
	G2-c	934	1,093	1,198	1,339
	G3-d	966	1,147	1,298	1,521
	G3-e	978	1,182	1,342	1,568
Commercial vehicle tires	G1	1,646	1,962	2,088	2,207
	G2	1,779	2,292	2,636	3,014
	G3	1,897	2,549	3,088	3,716
Other tires	G1	375	450	540	635
	G2	400	520	675	850
	G3	420	570	780	1,035
Total tires	G1-a	2,908	3,399	3,663	3,939
	G2-b	3,101	3,870	4,466	5,157
	G2-c	3,113	3,905	4,509	5,203
	G3-d	3,283	4,270	4,714	6,272
	G3-e	3,295	4,301	4,758	6,319

7.2.3 World demand for rubber

In section 7.2.1 and 7.2.2 preliminary NR-demand projections have been derived for the non-tire sector and for the tire sector.
Aggregating these two sectors, by adding the totals of table 7.3 and table 7.5, gives world demand for NR, excluding Asian Centrally Planned Economies. It has to be stressed again, that these projections are based on the assumption of the share of NR in each specific end-use remaining constant. Projection results are shown in table 7.6.

Table 7.6 World NR-demand (in thousand tons)

	scenario	1985	1990	1995	2000
World (excl. Asian	G1-a	4,261	5,026	5,624	6,249
CPE countries)	G2-b	4,528	5,731	6,885	8,225
	G2-c	4,540	5,766	6,928	8,271
	G3-d	4,774	6,317	7,508	9,990
	G3-e	4,786	6,348	7,552	10,037

As far as China is concerned, the current NR-share in total rubber consumption is 80 %. We assume that this will decline in future owing to the increasing openness of the Chinese economy, the ongoing efforts of developing a Chinese oil industry and the availability of NR. The NR-share and NR-demand are projected to develop as shown in table 7.7. China and the other Asian CPE countries are lumped together.

Table 7.7 NR-demand in Asian Centrally Planned Economies (in thousand tons)

	scenario	1985	1990	1995	2000
Projected NR percentage		70	60	50	40
NR-demand	G1	566	840	1,223	1,634
	G2	617	1,045	1,737	2,651
	G3	662	1,223	2,216	3,691

At this stage world totals (table 7.8) can be derived by adding tables 7.6 and 7.7.

Table 7.8 World NR-demand (in thousand tons)

	scenario	1985	1990	1995	2000
World	G1-a	4,827	5,866	6,847	7,883
	G2-b	5,145	6,776	8,622	10,876
	G2-c	5,157	6,811	8,665	10,922
	G3-d	5,436	7,540	9,724	13,681
	G3-e	5,448	7,571	9,768	13,728

7.3 NR versus SR - some tentative conclusions

This study on "Demand and supply of natural rubber" has as its objective to indicate a production policy that optimally meets demand for natural rubber. As has been stated in section 1.2, three parts of the rubber economy need to be studied in order to properly derive conclusions absout such a production policy:

a - to analyze total demand for rubber;

b - to analyze current and prospective production of rubber;

c - to assess and predict the share of NR in relation to

(1) technical aspects

(2) economic aspects

(3) availability of hevea and non-hevea types of rubber.

a. At this stage of the study, at the end of part I, total demand for rubber has been elaborately analyzed and forecasts have been presented for three economic scenarios (growth in GDP per country) and three saturation levels for passenger cars. It has been concluded that the effect of different saturation levels on rubber consumption is virtually zero. It is therefore adequate to concentrate on economic growth scenarios.

b. Natural rubber production has not yet been analyzed in detail. However, some scenarios for prospective NR production have been drawn up (table 7.1), as tentative projections. They are again presented in table 7.9.

Table 7.9 Scenarios for future production of NR (in thousand tons)

	scenario	1985	1990	1995	2000
World	I	4,335	4,930	5,425	5,870
	II	4,665	5,760	6,660	7,295
	III	4,925	6,215	7,920	8,865

The scenarios I, II and III refer to low, medium and high production forecasts. A more detailed analysis about feasibility and accuracy of these scenarios will be undertaken in part II of the study.

c. The NR-share in total rubber demand has not changed dramatically over the past decade. However, largely because of the introduction and further penetration of radial tires, the NR-share in the tire sector has increased. This increase therefore, can be attributed to technical factors. In the non-tire sector, on the other hand, NR has lost ground over the past decade, partly owing to the further penetration of special purpose rubbers and partly because of an increase in NR prices, which resulted from a lack of NR availability and increased SR prices. Over the past decade, the NR-share in the non-tire sector decreased e.g. from 19 % to 13 % in the USA, from 45 % to 23 % in the United Kingdom, from 38 % to 17 % in Germany en from 38 % to 21 % in Japan.

In general, it may be concluded that the current NR-share per end-use, certainly is not on the high side and might increase, if NR were available, perhaps in combination with some relative NR price decrease. This will be studied more in detail in part II. Here, the current NR-share per end-use has been applied to assess the future supply-demand situation for NR. Results have been derived in section 7.2 and are again summarized for the economic scenarios only in table 7.10.

Table 7.10 World NR-demand (in thousand tons)

	scenario	1985	1990	1995	2000
World	G1-a	4,827	5,866	6,847	7,883
	G2-b	5,145	6,780	8,623	10,876
	G3-d	5,436	7,536	9,723	13,681

In order to obtain information about supply-demand discrepancies for NR, supply-demand has been calculated for the 3 x 3 combinations of supply scenarios (I, II, III) and demand scenarios (G1, G2, G3). Results are shown in table 7.11.

Table 7.11 Supply minus demand for NR for 9 combinations of scenarios (in thousand tons)

	scenario combination	1985	1990	1995	2000
World	I-G1	-492	-936	-1,422	-2,013
	I-G2	-810	-1,846	-3,197	-5,006
	I-G3	-1,101	-2,610	-4,299	-7,811
	II-G1	-162	-106	-187	-588
	II-G2	-480	-1,016	-1,962	-3,581
	II-G3	-771	-1,780	-3,064	-6,386
	III-G1	98	349	1,073	982
	III-G2	-220	-561	-702	-2,011
	III-G3	-511	-1,325	-1,804	-4,816

It can therefore be concluded that "sufficient" NR will be available only in the combined case of low economic growth (G1) and extremely high NR production forecasts (III). Even in this case the very low calculated "surplus" would no doubt be absorbed through a slightly larger percentage share of NR in various end-uses. A preliminary conclusion from part I of this study, therefore, is that the highest NR production forecasts are unlikely to provide the world rubber industry with sufficient NR to maintain the present NR-share in all end-uses. As the present share is in a number of cases already low, not for technical reasons, but because of a certain scarcety, the preliminary conclusion is that NR capacity should be increased.

A P P E N D I X

Table A.1 Total rubber consumption, 1950-1975 (in tons)

	1955	1960	1965	1970	1975
USA	1,554,174	1,583,299	2,087,794	2,516,918	2,629,685
Canada	85,880	92,495	141,165	186,082	251,557
Brazil	40,304	61,161	64,413	122,093	235,050
Germany, F.R.	175,791	254,100	366,384	558,812	556,991
France	156,255	221,625	276,963	419,150	433,873
UK	273,913	300,500	369,400	461,800	436,800
Italy	70,003	133,000	200,000	310,000	338,000
Japan	n.a.	230,000	377,000	779,000	870,000
Sub-total	n.a.	2,876,180	3,883,119	5,353,855	5,751,956
Rest of the world excl. E. Europe and China	n.a.	517,070	851,631	1,496,145	1,888,544
Total excl. Eastern Europe and China	n.a.	3,393,250	4,734,750	6,850,000	7,640,500
E. Europe and China	n.a.	469,250	620,250	1,785,000	2,755,000
Grand Total World	2,945,000	3,862,500	5,355,000	8,635,000	10,395,000

Source: Rubber Statistical Bulletin

Table A.2 Rubber consumption in the tire sector (in tons)

	1955	1960	1965	1970	1975
USA	975,213	1,010,786	1,327,309	1,602,912	1,643,808
Canada	56,717	64,213	100,349	144,953	171,916
Brazil	n.a.	47,497	45,637	79,603	147,215
Germany F.R.	n.a.	139,550	207,400	284,000	262,420
France	92,179	126,052	160,369	262,427	283,677
United Kingdom	147,726	158,200	193,200	233,400	213,900
Italy	n.a.	71,000	111,000	159,000	161,900
Japan	n.a.	99,070	182,750	399,000	540,100
Total	n.a.	1,716,368	2,328,014	3,165,295	3,424,936

Source: Rubber Statistical Bulletin

Table A.3 Rubber consumption in the non-tire sector (in tons)

	1955	1960	1965	1970	1975
USA	578,961	572,513	760,485	914,006	987,877
Canada	29,163	28,282	40,816	41,129	92,108
Brazil	n.a.	13,664	18,776	42,490	87,835
Germany F.R.	n.a.	114,550	158,984	274,812	294,571
France	64,076	95,573	116,594	156,723	150,196
United Kingdom	126,187	142,300	176,200	228,400	222,900
Italy	n.a.	62,000	89,000	151,000	176,100
Japan	n.a.	130,930	194,250	380,000	329,900
Total	n.a.	1,159,812	1,555,105	2,188,560	2,341,487

Source: Rubber Statistical Bulletin

Table A.4 Percentage share of tire sector in total rubber consumption

	1955	1960	1965	1970	1975
USA	63	64	64	64	62
Canada	66	69	71	78	65
Brazil	n.a.	78	71	65	63
Germany F.R.	n.a.	55	57	51	47
France	59	57	58	63	65
United Kingdom	54	53	52	51	49
Italy	n.a.	53	56	51	48
Japan	n.a.	43	49	51	62
Sub-total	n.a.	60	60	59	59

Note: Derived from previous tables.

Table A.5 Production of natural rubber (in tons)

	1955	1960	1965	1970	1975
Malaysia*	638,748	785,405	949,243	1,269,203	1,459,282
Indonesia	737,088	620,252	716,642	815,161	822,500
Thailand	130,181	170,849	216,405	289,663	355,033
Sei Lanka	93,830	98,838	118,311	159,158	148,751
India	22,481	25,192	49,387	89,905	136,019
Others**	297,700	315,500	330,000	479,400	393,400
Total**	1,920,000	2,015,000	2,380,000	3,102,500	3,315,000

Source: Rubber Statistical Bulletin.

* includes Singapore for 1955

** including allowances for statistical discrepancies

Table A.6 Percentage share of synthetic rubber in total rubber consumption

	1955	1960	1965	1970	1975
USA	58.5	69.3	75.0	77.4	74.7
Canada	47.5	61.4	69.2	72.8	71.3
Japan	4.5	26.8	46.6	63.7	67.2
Australia	23.9	40.8	50.4	57.3	50.1
Germany F.R.	14.7	41.8	56.9	64.1	64.6
France	12.6	41.6	55.7	62.3	64.0
United Kingdom	7.9	39.2	49.5	58.7	61.0
Netherlands	10.1	36.0	49.7	67.6	71.6
Italy	18.6	43.6	56.5	63.6	65.1
Eastern Europe	0.1	10.3	22.9	69.5	80.8
Brazil	1.0	27.2	58.8	69.9	75.0
China	n.a.	11.6	0.7	18.6	19.6
India	0.4	12.5	24.0	26.9	19.9
Total world	36.0	52.1	61.2	65.3	67.6

Source: Rubber Statistical Bulletin.

Table A.7 Classification of countries and regions

I. North America

1. United States
2. Canada

II. Asia, developed

3. Japan

III. Oceania, developed

4. Australia
5. New Zealand

IV. North-West Europe

6. Germany F.R.
7. France
8. United Kingdom
9. Netherlands
10. Belgium + Luxemburg
11. Denmark
12. Iceland
13. Sweden
14. Switzerland
15. Ireland
16. Norway
17. Finland
18. Austria

V. South-West Europe

19. Italy
20. Spain
21. Portugal
22. Greece
23. Turkey
24. Yugoslavia
25. Other West Europe

VI. Eastern Europe

26. USSR
27. Csechoslovakia
28. Germany, D.R.
29. Hungary
30. Poland
31. Romania
32. Other Eastern Europe (Albania, Bulgaria)

VII. Latin America + Caribbean

33. Brazil
34. Argentina
35. Mexico
36. Others

VIII. Asia, Centrally Planned

37. China
38. Others (Afghanistan, Kampuchea, Laos, Mongolia, Vietnam)

IX. South Asia

39. India
40. Bangladesh
41. Pakistan
42. Sri Lanka
43. Others (Nepal, Burma, Bhutan)

X. South-East + East Asia

44. Indonesia
45. Malaysia
46. Philippines
47. Thailand
48. Singapore
49. Hong Kong
50. Korea
51. Other Oceania
52. Other Asia (excl. Middle East)

XI. Middle East + North Africa

53. Iran
54. Other oil producing + Israel [a]
55. Others [b]

XII. Other Africa

56. Nigeria
57. South Africa
58. Other Africa

Note: a) Algeria, Bahrain, Iraq, Israel, Kuwait, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, United Arab Emorates.

b) Cyprus, Egypt, Jordan, Lebanon, Morocco, Spanish Sahara, Syrian Arab Republic, Tunesia, Yemen.

Table A.8 Population estimates and projections, 1975-2000 (in millions)

		1975	1980	1985	1990	1995	2000
1	United States	213.6	222.2	232.2	241.6	249.0	255.6
2	Canada	22.7	24.0	25.5	26.8	27.8	28.9
3	Japan	111.6	117.0	120.7	123.2	125.2	127.2
4	Australia	13.8	14.6	15.3	15.9	16.4	16.8
5	New Zealand	3.1	3.1	3.2	3.3	3.3	3.3
6	Germany, Fed.Rep. of	61.8	61.0	60.6	60.7	60.6	60.2
7	France	52.8	53.6	54.0	54.3	54.4	54.4
8	United Kingdom	55.9	55.8	55.7	55.8	55.9	56.0
9	Netherlands	13.7	14.1	14.6	15.1	15.6	16.0
10	Belgium + Luxemburg	10.2	10.2	10.3	10.3	10.3	10.3
11	Denmark	5.1	5.1	5.2	5.2	5.3	5.3
12	Iceland	.2	.2	.2	.2	.2	.2
13	Sweden	8.2	8.3	8.5	8.6	8.6	8.7
14	Switzerland	6.4	6.3	6.1	6.0	5.8	5.7
15	Ireland	3.1	3.3	3.5	3.7	3.9	4.1
16	Norway	4.0	4.1	4.2	4.2	4.3	4.3
17	Finland	4.7	4.8	4.8	4.9	4.9	5.0
18	Austria	7.5	7.5	7.5	7.5	7.6	7.6
19	Italy	55.8	57.3	58.6	59.9	61.2	62.4
20	Spain	35.6	37.6	39.7	41.9	44.2	46.4
21	Portugal	9.6	9.9	10.3	10.7	11.1	11.5
22	Greece	9.1	9.6	10.2	10.8	11.5	12.2
23	Turkey	40.4	45.2	50.8	56.9	62.9	68.4
24	Yugoslavia	21.4	22.3	23.2	24.0	24.7	25.4
25	Other Western Europe	.5	.5	.5	.5	.5	.5
26	USSR	254.4	266.5	278.8	289.9	299.6	308.8
27	Csechoslovakia	14.8	15.4	15.9	16.3	16.8	17.4
28	Germany, DR	16.9	16.7	16.6	16.5	16.4	16.4
29	Hungary	10.5	10.8	11.0	11.1	11.2	11.3
30	Poland	34.0	35.7	37.2	38.6	39.8	41.0
31	Romania	21.3	22.3	23.2	24.3	25.4	26.5
32	Other Eastern Europe	11.1	11.6	12.0	12.3	12.7	13.0
33	Brazil	106.2	121.9	139.4	158.7	179.6	202.0
34	Argentina	25.4	27.1	28.7	30.2	31.6	32.9
35	Mexico	60.2	71.9	86.1	102.7	121.5	142.5
36	Other Latin America	125.8	143.1	162.7	184.2	207.0	230.6
37	China	895.3	958.5	1015.9	1064.1	1111.4	1157.6
38	Other Asia	91.9	98.5	105.6	112.9	119.9	126.2
39	India	600.8	664.7	732.4	[illegible]	866.2	924.6
40	Bangladesh	79.0	88.9	101.0	114.1	127.7	141.2
41	Pakistan	70.3	81.8	95.5	110.6	126.4	142.3
42	Sri Lanka	13.4	15.0	16.6	18.3	19.6	21.4
43	Other South Asia	43.0	47.1	50.9	54.8	58.1	61.1
44	Indonesia	135.2	152.1	170.1	188.2	205.7	221.7
45	Malaysia	11.9	13.7	15.7	17.7	19.5	21.1
46	Philippines	42.5	49.1	56.1	63.5	71.0	78.2
47	Thailand	41.9	47.4	53.2	59.2	64.9	70.3
48	Singapore	2.3	2.4	2.5	2.7	2.7	2.8
49	Hong Kong	4.4	4.8	5.2	5.6	5.9	6.2
50	Republic of Korea	35.3	38.2	41.3	44.4	47.2	49.6
51	Other Oceania	4.0	4.5	5.1	5.8	6.5	7.2
52	Other Asia	16.2	17.5	18.9	20.3	21.9	23.6
53	Iran	33.0	36.8	40.8	44.9	48.8	52.3
54	Other oil prod. Arab. countries	44.4	52.0	60.8	70.7	81.3	92.2
55	Other Middle East + North Africa	53.3	60.6	68.5	77.4	86.9	96.7
56	Nigeria	65.7	77.0	90.9	107.8	128.1	152.4
57	South Africa	25.5	29.3	33.6	38.3	43.8	49.9
58	Other Africa	230.0	264.4	305.9	355.0	412.5	477.4

Table A.9 Gross domestic product scenarios for growth

			1980	1981	1982	1983/1985	1986/1995	1996/2000
1	United States	G1	-1.3	-1.0	0	0.5	1.5	1.0
		G2		0.5	1.5	1.5	3.0	2.5
		G3		1.0	2.0	2.5	4.0	3.5
2	Canada	G1	1.5	1.5	1.5	2.0	2.5	2.0
		G2		2.0	2.5	3.0	4.0	3.5
		G3		2.5	3.0	4.0	5.0	4.5
3	Japan	G1	4.8	4.0	4.0	4.0	4.5	4.0
		G2		4.5	5.0	5.0	6.0	5.5
		G3		5.0	5.5	6.0	7.0	6.5
4	Australia	G1	2.8	2.5	3.0	3.5	3.5	3.0
		G2		3.0	4.0	4.5	5.0	4.5
		G3		3.5	4.5	5.5	6.0	5.5
5	New Zealand	G1	1.0	1.0	1.0	1.0	1.5	1.0
		G2		1.0	2.0	2.0	3.0	2.5
		G3		1.5	2.5	3.0	4.0	3.5
6	Germany, Fed. Rep. of	G1	2.3	2.0	2.5	3.0	3.5	3.0
		G2		2.5	3.5	4.0	5.0	4.5
		G3		3.0	4.0	5.0	6.0	5.5
7	France	G1	2.0	2.0	2.0	2.5	3.0	2.5
		G2		2.0	3.0	3.5	4.5	4.0
		G3		2.5	3.5	4.5	5.5	5.0
8	United Kingdom	G1	-2.0	-1.0	0	0.5	1.5	1.0
		G2		1.0	1.0	1.5	3.0	2.5
		G3		1.5	1.5	2.5	4.0	3.5
9	Netherlands	G1	1.8	1.5	1.5	2.0	2.5	2.0
		G2		2.0	2.5	3.0	4.0	3.5
		G3		2.5	3.0	4.0	5.0	4.5
10	Belgium + Luxemburg	G1	2.5	2.0	2.0	2.5	3.0	2.5
		G2		2.5	3.0	3.5	4.5	4.0
		G3		3.0	3.5	4.5	5.5	5.0
11	Denmark	G1	0.8	0.5	0.5	1.0	1.5	1.0
		G2		1.0	1.5	2.0	3.0	2.5
		G3		1.5	2.0	3.0	4.0	3.5
12	Iceland	G1	2.0	1.5	1.5	1.5	2.0	1.5
		G2		2.0	2.5	2.5	3.5	3.0
		G3		2.5	3.0	3.5	4.5	4.0
13	Sweden	G1	3.0	2.5	2.5	2.5	3.0	2.5
		G2		3.0	3.5	3.5	4.5	4.0
		G3		3.5	4.0	4.5	5.5	5.0
14	Switzerland	G1	2.0	1.5	1.5	1.5	2.0	1.5
		G2		2.0	2.5	2.5	3.5	3.0
		G3		2.5	3.0	3.5	4.5	4.0
15	Ireland	G1	3.0	2.5	2.5	3.0	3.5	3.0
		G2		3.0	3.5	4.0	5.0	4.5
		G3		3.5	4.0	5.0	6.0	5.5

Table A.9 - continued

			1980	1981	1982	1983/1985	1986/1995	1996/2000
16	Norway	G1	4.3	3.5	3.5	3.5	4.0	3.5
		G2		4.5	4.5	4.5	5.5	5.0
		G3		5.0	5.0	5.5	6.5	6.0
17	Finland	G1	4.5	4.0	4.0	4.0	4.5	4.0
		G2		4.5	5.0	5.0	6.0	5.5
		G3		5.0	5.5	6.0	7.0	6.5
18	Austria	G1	2.0	1.5	2.0	2.5	3.0	2.5
		G2		2.0	3.0	3.5	4.5	4.0
		G3		2.5	3.5	4.5	5.5	5.0
19	Italy	G1	2.0	1.5	2.0	2.5	3.0	2.5
		G2		2.0	3.0	3.5	4.5	4.0
		G3		2.5	3.5	4.5	5.5	5.0
20	Spain	G1	1.0	0.5	0.5	1.0	1.0	0.5
		G2		1.0	1.5	2.0	2.5	2.0
		G3		1.5	2.0	3.0	3.5	3.0
21	Portugal	G1	2.3	2.0	2.0	2.5	3.0	2.5
		G2		2.5	3.0	3.5	4.5	4.0
		G3		3.0	3.5	4.5	5.5	5.0
22	Greece	G1	1.0	0.5	0.5	1.0	1.5	1.0
		G2		1.0	1.5	2.0	3.0	2.5
		G3		1.5	2.0	3.0	4.0	3.5
23	Turkey	G1	1.0	0.5	0.5	1.0	1.5	1.0
		G2		1.0	1.5	2.0	3.0	2.5
		G3		1.5	2.0	3.0	4.0	3.5
24	Yugoslavia	G1	4.0	3.5	3.5	4.0	4.5	4.0
		G2		4.0	4.5	5.0	6.0	5.5
		G3		4.5	5.0	6.0	7.0	6.5
25	Other Western Europe	G1	2.0	1.5	2.0	2.5	3.0	2.5
		G2		2.0	3.0	3.5	4.5	4.0
		G3		2.5	3.5	4.5	5.5	5.0
26	USSR	G1	3.0	2.5	2.5	3.0	3.5	3.0
		G2		3.0	3.5	4.0	5.0	4.5
		G3		3.5	4.0	5.0	6.0	5.5
27	Csechoslovakia	G1	3.0	2.5	2.5	3.0	3.5	3.0
		G2		3.0	3.5	4.0	5.0	4.5
		G3		3.5	4.0	5.0	6.0	5.5
28	Germany, DR	G1	3.5	3.0	3.0	3.5	4.0	3.5
		G2		3.5	4.0	4.5	5.5	5.0
		G3		4.0	4.5	5.5	6.5	6.0
29	Hungary	G1	4.0	3.5	3.5	4.0	4.5	4.0
		G2		4.0	4.5	5.0	6.0	5.5
		G3		4.5	5.0	6.0	7.0	6.5
30	Poland	G1	4.0	3.5	3.5	4.0	4.5	4.0
		G2		4.0	4.5	5.0	6.0	5.5
		G3		4.5	5.0	6.0	7.0	6.5

Table A.9 - continued

			1980	1981	1982	1983/1985	1986/1995	1996/2000
31	Romania	G1	6.0	5.5	5.5	6.0	6.5	6.0
		G2		6.0	6.5	7.0	8.0	7.5
		G3		6.5	7.0	8.0	9.0	8.5
32	Other Eastern Europe	G1	4.0	3.5	3.5	4.0	4.5	4.0
		G2		4.0	4.5	5.0	6.0	5.5
		G3		4.5	5.0	6.0	7.0	6.5
33	Brazil	G1	5.0	4.5	4.5	5.0	5.5	5.0
		G2		5.0	5.5	6.0	7.0	6.5
		G3		5.5	6.0	7.0	8.0	7.5
34	Argentina	G1	0.0	0.0	0.5	1.0	1.5	1.0
		G2		0.5	1.5	2.0	3.0	2.5
		G3		1.0	2.0	3.0	4.0	3.5
35	Mexico	G1	6.0	5.5	5.5	6.0	6.5	6.0
		G2		6.0	6.5	7.0	8.0	7.5
		G3		6.5	7.0	8.0	9.0	8.5
36	Other Latin America	G1	2.0	1.5	1.5	2.0	2.5	2.0
		G2		2.0	2.5	3.0	4.0	3.5
		G3		2.5	3.0	4.0	5.0	3.5
37	China	G1	5.5	5.0	5.0	5.5	6.0	5.5
		G2		5.5	6.0	6.5	7.5	7.0
		G3		6.0	6.5	7.5	8.5	8.0
38	Other Asia	G1	1.0	0.5	0.5	1.0	1.5	1.0
		G2		1.0	1.5	2.0	3.0	2.5
		G3		1.5	2.0	3.0	4.0	3.5
39	India	G1	5.0	4.5	4.5	5.0	5.5	5.0
		G2		5.0	5.5	6.0	7.0	6.5
		G3		5.5	6.0	7.0	8.0	7.5
40	Bangladesh	G1	5.0	4.5	4.5	5.0	5.5	5.0
		G2		5.0	5.5	6.0	7.0	6.5
		G3		5.5	6.0	7.0	8.0	7.5
41	Pakistan	G1	5.0	4.5	4.5	5.0	5.5	5.0
		G2		5.0	5.5	6.0	7.0	6.5
		G3		5.5	6.0	7.0	8.0	7.5
42	Sri Lanka	G1	6.0	5.5	5.5	6.0	6.5	6.0
		G2		6.0	6.5	7.0	8.0	7.5
		G3		6.5	7.0	8.0	9.0	8.5
43	Other South Asia	G1	3.0	2.5	2.5	3.0	3.5	3.0
		G2		3.0	3.5	4.0	5.0	4.5
		G3		3.5	4.0	5.0	6.0	5.5
44	Indonesia	G1	5.5	5.0	5.0	5.5	6.0	5.5
		G2		5.5	6.0	6.5	7.5	6.0
		G3		6.0	6.5	7.5	8.5	8.0
45	Malaysia	G1	5.5	5.0	5.0	5.5	6.0	5.5
		G2		5.5	6.0	6.5	7.5	7.0
		G3		6.0	6.5	7.5	8.5	8.0

Table A.9 - continued

			1980	1981	1982	1983/1985	1986/1995	1996/2000
46	Philippines	G1	4.5	4.0	4.0	4.5	5.0	4.5
		G2		4.5	5.0	5.5	6.5	6.0
		G3		5.0	5.5	6.5	7.5	7.0
47	Thailand	G1	6.0	5.5	5.5	6.0	6.5	6.0
		G2		6.0	6.5	7.0	8.0	7.5
		G3		6.5	7.0	8.0	9.0	8.5
48	Singapore	G1	6.0	5.5	5.5	6.0	6.5	6.0
		G2		6.0	6.5	7.0	8.0	7.5
		G3		6.5	7.0	8.0	9.0	8.5
49	Hong Kong	G1	7.0	6.0	6.0	6.5	7.0	6.5
		G2		6.5	7.0	7.5	8.5	8.0
		G3		7.0	7.5	8.5	7.5	9.0
50	Korea	G1	6.5	6.0	6.0	6.5	7.0	6.5
		G2		6.5	7.0	7.5	8.5	8.0
		G3		7.0	7.5	8.5	9.5	9.0
51	Other Oceania	G1	4.0	3.5	3.5	4.0	4.5	4.0
		G2		4.0	4.5	5.0	6.0	5.5
		G3		4.5	5.0	6.0	7.0	6.5
52	Other Asia	G1	7.0	6.5	6.5	7.0	7.5	7.0
		G2		7.0	7.5	8.0	9.0	8.5
		G3		7.5	8.0	9.0	10.0	9.5
53	Iran	G1	0.0	0.0	0.5	1.5	2.0	1.5
		G2		0.5	1.5	2.5	3.5	3.0
		G3		1.0	1.5	2.5	4.5	4.0
54	Other oil. prod. Arab. countries	G1	3.5	3.0	3.0	3.5	4.0	3.5
		G2		3.5	4.0	4.5	5.5	5.0
		G3		4.0	4.5	5.5	6.5	6.0
55	Other Middle East + North Africa	G1	5.0	4.5	4.5	5.0	5.5	5.0
		G2		5.0	5.5	6.0	7.0	6.5
		G3		5.5	6.0	7.0	8.0	7.5
56	Nigeria	G1	3.0	2.5	2.5	3.0	3.5	3.0
		G2		3.0	3.5	4.0	5.0	4.5
		G3		3.5	4.0	5.0	6.0	5.5
57	South Africa	G1	1.0	0.5	0.5	1.0	1.5	1.0
		G2		1.0	1.5	2.0	3.0	2.5
		G3		1.5	2.0	3.0	4.0	3.5
58	Other Africa	G1	0.0	0.0	0.0	0.5	1.0	0.5
		G2		0.5	1.0	1.5	2.5	2.0
		G3		1.0	1.5	2.5	3.5	3.0

Table A.10 Gross domestic product per capita, estimates and scenario's (in 1975 constant $ U.S.)

			1975	1980	1985	1990	1995	2000
1	United States	G1	7.189	8.060	7.751	8.023	8.386	8.588
		G2	7.189	8.060	8.227	9.165	10.308	11.363
		G3	7.189	8.060	8.557	10.004	11.809	13.665
2	Canada	G1	6.934	7.693	7.940	8.551	9.313	9.937
		G2	6.934	7.693	8.297	9.609	11.254	12.917
		G3	6.934	7.693	8.625	10.478	12.873	15.504
3	Japan	G1	4.371	5.502	6.496	7.925	9.716	11.637
		G2	4.371	5.502	6.776	8.885	11.697	15.050
		G3	4.371	5.502	7.038	9.673	13.346	18.001
4	Australia	G1	6.487	7.100	7.917	9.040	10.417	11.784
		G2	6.487	7.100	8.268	10.145	12.562	15.276
		G3	6.487	7.100	8.590	11.052	14.349	18.300
5	New Zealand	G1	4.208	4.172	4.298	4.560	4.847	5.034
		G2	4.208	4.172	4.470	5.104	5.838	6.528
		G3	4.208	4.172	4.635	5.554	6.667	7.826
6	Germany, Fed. Rep. of	G1	6.940	8.357	9.608	11.398	13.557	15.820
		G2	6.940	8.357	10.036	12.793	16.353	20.512
		G3	6.940	8.357	10.425	13.939	18.682	24.577
7	France	G1	6.417	7.441	8.266	9.542	11.039	12.488
		G2	6.417	7.441	8.594	10.664	13.262	16.134
		G3	6.417	7.441	8.932	11.624	15.161	19.348
8	United Kingdom	G1	4.009	4.285	4.310	4.636	4.985	5.228
		G2	4.009	4.285	4.575	5.296	6.128	6.918
		G3	4.009	4.285	4.758	5.780	7.020	8.320
9	Netherlands	G1	5.976	6.727	7.107	7.780	8.547	9.202
		G2	5.976	6.727	7.426	8.742	10.328	11.961
		G3	5.976	6.727	7.720	9.533	11.815	14.356
10	Belgium + Luxemburg	G1	6.364	7.283	8.117	9.380	10.862	12.302
		G2	6.364	7.283	8.480	10.534	13.114	15.970
		G3	6.364	7.283	8.813	11.493	14.991	19.152
11	Denmark	G1	6.569	7.387	7.608	8.129	8.671	9.041
		G2	6.569	7.387	7.954	9.145	10.497	11.782
		G3	6.569	7.387	8.271	9.980	12.023	14.166
12	Iceland	G1	5.864	7.055	7.815	8.590	9.858	10.995
		G2	5.864	7.055	8.171	9.656	11.922	14.310
		G3	5.864	7.055	8.493	10.533	13.642	17.188
13	Sweden	G1	8.474	9.023	10.070	11.535	13.236	14.812
		G2	8.474	9.023	10.520	12.953	15.978	19.228
		G3	8.474	9.023	10.933	14.119	18.265	23.057
14	Switzerland	G1	8.390	8.849	9.762	11.058	12.534	13.886
		G2	8.390	8.849	10.202	12.432	15.158	18.071
		G3	8.390	8.849	10.606	13.562	17.350	21.708
15	Ireland	G1	2.604	3.001	3.250	3.661	4.122	4.553
		G2	2.604	3.001	3.394	4.109	4.972	5.903
		G3	2.604	3.001	3.527	4.477	5.680	7.072

Table A.10 - continued

			1975	1980	1985	1990	1995	2000
16	Norway	G1	7.130	8.581	10.032	12.049	14.477	17.026
		G2	7.130	8.581	10.526	13.581	17.529	22.154
		G3	7.130	8.581	10.935	14.790	20.011	26.519
17	Finland	G1	5.696	6.421	7.726	9.520	11.755	14.173
		G2	5.696	6.421	8.066	10.673	14.152	18.329
		G3	5.696	6.421	8.378	11.618	16.147	21.923
18	Austria	G1	5.013	6.025	6.719	7.762	8.969	10.119
		G2	5.013	6.025	7.019	8.717	10.829	13.136
		G3	5.013	6.025	7.295	9.502	12.379	15.753
19	Italy	G1	3.116	3.567	3.886	4.408	5.005	5.551
		G2	3.116	3.567	4.062	4.951	6.042	7.206
		G3	3.116	3.567	4.221	5.397	6.908	8.641
20	Spain	G1	2.835	2.984	2.941	2.927	2.920	2.850
		G2	2.835	2.984	3.074	3.294	3.537	3.718
		G3	2.835	2.984	3.197	3.596	4.053	4.474
21	Portugal	G1	1.465	1.725	1.864	2.080	2.326	2.551
		G2	1.465	1.725	1.947	2.336	2.808	3.312
		G3	1.465	1.725	2.023	2.546	3.210	3.971
22	Greece	G1	2.317	2.670	2.616	2.651	2.690	2.672
		G2	2.317	2.670	2.734	2.982	3.257	3.482
		G3	2.317	2.670	2.844	3.255	3.730	4.187
23	Turkey	G1	.891	.958	.887	.854	.832	.804
		G2	.891	.958	.928	.961	1.007	1.048
		G3	.891	.958	.965	1.049	1.153	1.260
24	Yugoslavia	G1	1.669	2.083	2.414	2.906	3.513	4.161
		G2	1.669	2.083	2.520	3.258	4.230	5.382
		G3	1.669	2.083	2.618	3.547	4.826	6.437
25	Other Western Europe	G1	2.000	2.352	2.571	2.923	3.325	3.691
		G2	2.000	2.352	2.686	3.283	4.013	4.793
		G3	2.000	2.352	2.845	3.648	4.677	5.859
26	USSR	G1	1.907	2.112	2.317	2.647	3.042	3.422
		G2	1.907	2.112	2.420	2.971	3.669	4.436
		G3	1.907	2.112	2.515	3.237	4.191	5.315
27	Csechoslovakia	G1	3.203	3.795	4.218	4.868	5.617	6.277
		G2	3.203	3.795	4.406	5.464	6.775	8.139
		G3	3.203	3.795	4.578	5.953	7.740	9.751
28	Germany, DR	G1	3.490	4.316	5.111	6.253	7.643	9.099
		G2	3.490	4.316	5.338	7.015	9.210	11.783
		G3	3.490	4.316	5.545	7.640	10.515	14.105
29	Hungary	G1	2.590	3.219	3.818	4.705	5.804	6.965
		G2	2.590	3.219	3.986	5.275	6.988	9.008
		G3	2.590	3.219	4.140	5.743	7.973	10.775
30	Poland	G1	2.184	2.667	3.080	3.707	4.480	5.286
		G2	2.184	2.667	3.216	4.156	5.394	6.836
		G3	2.184	2.667	3.340	4.525	6.154	8.177

Table A.10 - continued

			1975	1980	1985	1990	1995	2000
31	Romania	G1	2.292	3.223	4.092	5.371	7.034	9.000
		G2	2.292	3.223	4.269	6.009	8.439	11.585
		G3	2.292	3.223	4.431	6.532	9.606	13.811
32	Other Eastern Europe	G1	1.445	1.768	2.067	2.500	3.032	3.602
		G2	1.445	1.768	2.158	2.803	3.650	4.659
		G3	1.445	1.768	2.241	3.051	4.165	5.573
33	Brazil	G1	1.028	1.206	1.333	1.530	1.768	2.006
		G2	1.028	1.206	1.391	1.714	2.125	2.589
		G3	1.028	1.206	1.445	1.865	2.421	3.091
34	Argentina	G1	1.840	1.725	1.686	1.725	1.777	1.795
		G2	1.840	1.725	1.762	1.941	2.151	2.339
		G3	1.840	1.725	1.833	2.118	2.464	2.812
35	Mexico	G1	1.315	1.421	1.573	1.807	2.093	2.387
		G2	1.315	1.421	1.641	2.022	2.511	3.073
		G3	1.315	1.421	1.703	2.198	2.859	3.664
36	Other Latin America	G1	.852	.880	.847	.846	.852	.844
		G2	.852	.880	.885	.951	1.030	1.097
		G3	.852	.880	.920	1.037	1.178	1.317
37	China	G1	.331	.395	.483	.617	.791	.992
		G2	.331	.395	.504	.691	.950	1.279
		G3	.331	.395	.523	.751	1.081	1.526
38	Other Asia	G1	.196	.192	.186	.188	.191	.190
		G2	.196	.192	.195	.211	.231	.248
		G3	.196	.192	.203	.231	.264	.298
39	India	G1	.145	.169	.194	.232	.281	.336
		G2	.145	.169	.203	.260	.338	.433
		G3	.145	.169	.211	.283	.385	.517
40	Bangladesh	G1	.113	.137	.152	.176	.205	.237
		G2	.113	.137	.159	.197	.247	.306
		G3	.113	.137	.165	.214	.281	.365
41	Pakistan	G1	.186	.206	.223	.251	.288	.326
		G2	.186	.206	.232	.281	.346	.420
		G3	.186	.206	.241	.306	.394	.502
42	Sri Lanka	G1	.253	.303	.363	.452	.578	.708
		G2	.253	.303	.379	.506	.694	.911
		G3	.253	.303	.393	.550	.789	1.086
43	Other South Asia	G1	.101	.111	.118	.130	.145	.160
		G2	.101	.111	.123	.146	.175	.208
		G3	.101	.111	.128	.159	.200	.249
44	Indonesia	G1	.225	.276	.320	.387	.473	.574
		G2	.225	.276	.334	.433	.568	.740
		G3	.225	.276	.346	.471	.647	.883
45	Malaysia	G1	.782	.974	1.104	1.308	1.587	1.915
		G2	.782	.974	1.151	1.464	1.906	2.467
		G3	.782	.974	1.195	1.592	2.171	2.944

Table A.10 - continued

		1975	1980	1985	1990	1995	2000
46 Philippines	G1	.370	.421	.455	.513	.586	.662
	G2	.370	.421	.475	.575	.705	.856
	G3	.370	.421	.493	.626	.803	1.022
47 Thailand	G1	.347	.438	.517	.639	.796	.985
	G2	.347	.438	.540	.713	.955	1.267
	G3	.347	.438	.560	.775	1.087	1.511
48 Singapore	G1	2.507	3.386	4.239	5.534	7.330	9.572
	G2	2.507	3.386	4.422	6.191	8.795	12.321
	G3	2.507	3.386	4.590	6.730	10.011	14.689
49 Hong Kong	G1	1.666	2.553	3.198	4.164	5.493	7.146
	G2	1.666	2.553	3.335	4.657	6.586	9.188
	G3	1.666	2.553	3.461	5.060	7.491	10.944
50 Republic of Korea	G1	.574	.850	1.067	1.393	1.840	2.399
	G2	.574	.850	1.113	1.558	2.206	3.084
	G3	.574	.850	1.156	1.692	2.509	3.674
51 Other Oceania	G1	.983	1.063	1.132	1.249	1.389	1.529
	G2	.983	1.063	1.182	1.401	1.673	1.978
	G3	.983	1.063	1.228	1.525	1.909	2.365
52 Other Asia	G1	.525	.760	.980	1.306	1.741	2.267
	G2	.525	.760	1.022	1.460	2.085	2.911
	G3	.525	.760	1.061	1.586	2.371	3.464
53 Iran	G1	1.607	1.643	1.554	1.559	1.584	1.594
	G2	1.607	1.643	1.625	1.753	1.916	2.075
	G3	1.607	1.643	1.633	1.849	2.120	2.409
54 Other oil. prod. Arabian countries	G1	2.610	2.775	2.789	2.919	3.088	3.235
	G2	2.610	2.775	2.912	3.275	3.721	4.189
	G3	2.610	2.775	3.026	3.567	4.249	5.014
55 Other Middle East + North Africa	G1	.915	1.117	1.251	1.446	1.682	1.930
	G2	.915	1.117	1.306	1.619	2.022	2.490
	G3	.915	1.117	1.356	1.761	2.304	2.973
56 Nigeria	G1	.383	.440	.428	.429	.428	.417
	G2	.383	.440	.447	.481	.517	.541
	G3	.383	.440	.464	.524	.590	.649
57 South Africa	G1	1.451	1.343	1.218	1.150	1.085	1.001
	G2	1.451	1.343	1.273	1.293	1.314	1.305
	G3	1.451	1.343	1.324	1.412	1.505	1.569
58 Other Africa	G1	.326	.294	.258	.233	.211	.187
	G2	.326	.294	.269	.263	.256	.244
	G3	.326	.294	.280	.287	.293	.294

Table A.11 Passenger cars in use per 1,000 persons

	1950	1955	1960	1965	1970	1975
1. United States	265.4	314.3	341.3	387.6	435.5	499.6
2. Canada	139.2	186.9	229.3	268.0	310.0	390.7
3. Japan	0.5	1.7	4.9	22.3	84.7	154.4
4. Australia	93.4	146.4	196.6	254.0	309.4	363.2
5. New Zealand	125.3	179.5	215.0	275.4	318.2	376.8
6. Germany, Fed. Rep. of	12.0	34.6	78.3	152.1	222.6	290.1
7. France	n.a.	69.7	121.4	196.7	253.9	289.8
8. United Kingdom	n.a.	71.3	108.1	170.0	215.8	255.2
9. Netherlands	13.9	24.8	45.4	103.5	173.7	248.1
10. Belgium + Luxemburg	36.0	54.8	83.2	143.1	215.5	267.6
11. Denmark	27.6	50.0	88.7	155.2	220.1	254.9
12. Iceland	42.0	62.0	86.9	147.4	200.0	295.8
13. Sweden	36.1	87.3	159.2	233.0	286.1	336.6
14. Switzerland	31.3	54.2	94.3	153.2	223.1	280.3
15. Ireland	31.0	45.5	62.1	98.3	135.9	166.5
16. Norway	19.9	35.9	62.5	125.7	191.5	238.5
17. Finland	6.7	19.8	41.6	98.9	151.5	211.9
18. Austria	7.4	20.4	57.7	108.4	161.8	229.5
19. Italy	7.3	18.2	39.7	105.4	189.6	269.9
20. Spain	3.3	4.5	9.3	25.3	70.6	135.0
21. Portugal	7.1	11.0	18.0	31.7	65.8	114.0
22. Greece	1.1	2.5	5.2	12.1	25.7	48.2
23. Turkey	0.6	1.3	1.7	2.8	3.9	9.9
24. Yugoslavia	0.4	0.7	2.9	9.7	35.3	71.8
25. Other Western Europe	n.a.	n.a.	56.6	78.3	130.8	169.7
26-32. Eastern Europe and USSR	n.a.	n.a.	4.2	7.5	14.5	23.4
33. Brazil	4.3	6.9	8.8	16.0	25.1	38.7
34. Argentina	18.5	18.0	23.0	41.2	60.8	88.0
35. Mexico	6.5	10.0	13.1	17.8	24.5	40.6
36. Other Latin America + Caribbean	8.6	11.6	13.7	17.5	23.1	25.[illegible] [c]
37-38. Asia, Centrally Planned	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
39. India	0.4	0.5	0.7	0.9	1.1	1.2
40-43. South Asia, excl. India	n.a.	n.a.	1.7 [a]	2.1 [a]	2.3 [a]	2.4 [a]
41. Pakistan	0.6	0.7	1.2	2.1	2.5	2.7
42. Sri Lanka	0.4	0.7	0.8	1.0	1.1	1.1

Table A.11 - continued

	1950	1955	1960	1965	1970	1975
44. Indonesia	0.4	0.8	1.1	1.6	2.0	2.8
45. Malaysia	4.2	8.4	13.2	19.4	26.6	39.4
46. Philippines	2.1	2.4	3.2	4.3	7.4	8.6
47. Thailand	0.5	1.1	1.8	2.2	5.2	6.4
48. Singapore	17.6	32.2	41.0	57.4	70.8	66.3
49. Hong Kong	5.1	6.8	10.4	15.2	24.6	28.4
50. Republic of Korea	n.a.	0.3	0.5	0.6	1.9	2.4
53. Iran	0.9	1.5	4.3	5.5	9.8	23.8
53+54. Iran, Other oil producing + Israel	n.a.	n.a.	8.3 a)	12.5 a)	18.5 a)	28.8 a)
55. Other Middle East + North Africa	n.a.	n.a.	7.4 a)	8.1 a)	9.7 a)	12.2 a)
56. Nigeria	n.a.	n.a.	0.6	1.0	0.9	2.6
57. South Africa	32.5	36.1	48.3	61.4	71.8	85.8
56-58. Other Africa	n.a.	n.a.	6.6 a)	7.9 a)	9.9 a)	10.8 a)

Note: a) own estimates.

Table A.12. Projections of passenger cars per 1.000 persons, standard scenario (see text).

	1985	1990	1995	2000
1. United States	542.4	547.7	562.3	571.2
2. Canada	488.6	524.3	561.4	583.2
3. Japan	246.1	294.3	315.7	319.5
4. Australia	450.9	510.5	564.4	596.1
5. New Zealand	424.8	459.5	498.6	528.7
6. Germany, F.R.	438.8	464.6	469.4	469.9
7. France	347.3	369.8	396.1	419.8
8. United Kingdom	273.2	277.7	282.0	285.5
9. Netherlands	313.5	327.9	338.6	344.2
10. Belgium + Luxemburg	329.8	348.0	364.1	374.9
11. Denmark	290.4	298.5	307.8	315.6
12. Iceland	386.2	418.8	460.9	489.1
13. Sweden	392.7	416.1	426.3	429.1
14. Switzerland	350.0	383.7	396.4	399.2
15. Ireland	250.7	316.3	367.5	384.3
16. Norway	448.2	467.9	469.6	469.9
17. Finland	281.2	307.4	317.5	319.6
18. Austria	366.4	408.8	425.4	429.1
19. Italy	353.2	390.8	418.7	431.5
20. Spain	209.5	215.7	217.5	217.2
21. Portugal	143.8	164.5	187.8	209.2
22. Greece	76.7	79.6	82.8	81.3
23. Turkey	10.0	9.0	8.4	7.6
24. Yugoslavia	138.0	176.3	221.0	267.8
25. Other West Europe	196.8	212.4	224.7	232.4
26-32. Eastern Europe	37.6	45.4	55.1	65.0
33. Brazil	55.3	65.6	77.7	89.8
34. Argentina	97.6	105.6	114.3	120.9
35. Mexico	66.4	89.6	122.9	163.3
36. Other Latin America	28.0	28.0	28.4	27.8
39. India	1.8	2.1	2.5	2.9
40-43. Other South Asia	3.6	4.6	5.8	7.1
44. Indonesia	5.0	6.5	8.4	11.0
45. Malaysia	67.9	97.5	141.4	204.7
46. Philippines	14.3	20.6	30.3	43.7
47. Thailand	18.1	30.6	52.2	88.4
48. Singapore	63.2	64.7	66.4	68.1
49. Hong Kong	36.9	41.6	45.4	47.8
50-52. Korea and Others	10.6	13.4	17.1	21.6
53-54. Oil producing	37.5	39.8	43.2	46.2
55. Other M.E.+N. Africa	33.8	37.9	42.5	47.3
56-58. Other Africa	13.2	14.7	16.2	17.6

Table A.13. Projections of passenger cars per 1000 persons, by broad regions, for 5 scenarios (see text).

		scenario	1985	1990	1995	2000
I.	North America	a	537.1	545.4	562.2	572.5
		b	551.0	575.4	592.9	598.6
		c	561.0	597.8	630.4	643.7
		d	571.0	618.8	644.0	649.7
		e	575.1	637.9	682.2	696.4
II.	Asia, developed	a	246.1	294.3	315.7	319.5
		b	253.1	307.1	319.3	320.0
		c	246.0	317.6	346.8	349.9
		d	252.1	329.8	349.1	350.0
		e	255.6	351.0	378.6	380.0
III.	Oceania, developed	a	446.4	501.8	553.4	584.9
		b	456.4	537.2	594.2	614.7
		c	456.0	547.7	629.4	665.5
		d	465.2	578.9	655.4	676.3
		e	466.9	594.6	694.3	725.3
IV.	North-West Europe	a	350.5	370.1	382.1	389.9
		b	354.9	378.6	393.4	403.8
		c	361.3	392.8	412.2	426.3
		d	365.7	400.1	421.8	438.1
		e	372.4	415.7	442.1	462.4
V.	South-West Europe	a	181.5	195.0	205.3	211.0
		b	186.3	208.4	223.8	235.4
		c	187.2	213.3	232.5	245.0
		d	191.8	224.7	247.9	268.4
		e	192.6	229.4	255.7	276.8
VI.	Eastern Europe	a	37.6	45.4	55.1	65.0
		b	39.6	51.9	68.0	86.4
		c	39.6	51.9	68.0	86.4
		d	41.4	57.2	78.7	105.0
		e	41.4	57.2	78.7	105.0
VII.	Latin America + Caribbean	a	49.8	58.8	71.1	85.2
		b	53.6	71.2	97.5	132.8
		c	53.6	71.2	97.5	132.8
		d	57.2	82.4	123.1	183.6
		e	57.2	82.4	123.1	183.6
IX.	South Asia	a	2.3	2.8	3.4	4.1
		b	2.4	3.1	4.0	5.1
		c	2.4	3.1	4.0	5.1
		d	2.4	3.3	4.6	6.1
		e	2.4	3.3	4.6	6.1

Table A.13 (cont.)

		scenario	1985	1990	1995	2000
X.	South-East +	a	12.8	18.2	26.4	38.7
	East Asia	b	13.3	20.0	31.0	48.5
		c	13.3	20.0	31.0	48.5
		d	13.7	21.5	34.8	57.0
		e	13.7	21.5	34.8	57.0
XI.	Middle East +	a	36.0	39.1	42.9	46.6
	North Africa	b	37.8	44.5	53.1	62.8
		c	37.8	44.5	53.1	62.8
		d	39.1	48.7	61.7	77.4
		e	39.1	48.7	61.7	77.4
XII.	Other Africa	a	13.2	14.7	16.2	17.6
		b	13.4	15.2	16.9	18.7
		c	13.4	15.2	16.9	18.7
		d	13.5	15.6	17.6	19.6
		e	13.5	15.6	17.6	19.6

Table A.14. Projections of passenger cars in use, (in thousands), standard scenario (see text).

	1985	1990	1995	2000
1. United States	125946.7	132350.5	140047.2	146013.2
2. Canada	12442.1	14026.0	15602.0	16771.2
3. Japan	29708.5	36252.7	39537.4	40645.7
4. Australia	6894.1	8118.6	9251.9	10013.5
5. New Zealand	1360.3	1493.7	1643.0	1762.6
6. Germany, F.R.	26585.0	28178.7	28427.8	28273.6
7. France	18767.8	20069.2	21539.4	22834.0
8. United Kingdom	15228.3	15498.6	15770.4	15998.9
9. Netherlands	4586.1	4957.9	5271.8	5494.8
10. Belgium + Luxemburg	3391.4	3589.5	3759.3	3867.6
11. Denmark	1503.9	1558.6	1622.9	1677.3
12. Iceland	81.5	88.8	94.0	96.4
13. Sweden	3319.9	3560.4	3685.5	3750.1
14. Switzerland	2150.0	2297.0	2311.8	2263.9
15. Ireland	881.2	1172.2	1436.4	1576.7
16. Norway	1862.7	1969.9	2002.1	2022.9
17. Finland	1359.2	1502.4	1566.1	1591.0
18. Austria	2749.7	3078.6	3213.7	3250.6
19. Italy	20694.6	23409.4	25609.3	26929.1
20. Spain	8317.6	9040.7	9604.2	10076.1
21. Portugal	1483.6	1762.0	2085.7	2397.0
22. Greece	781.6	861.7	952.3	989.3
23. Turkey	510.2	513.9	527.9	522.7
24. Yugoslavia	3197.0	4229.2	5463.0	6801.7
25. Other West Europe	100.3	110.5	119.1	125.5
26-32. Eastern Europe	14825.8	18581.8	23234.2	28221.6
33. Brazil	7705.5	10415.3	13951.5	18135.8
34. Argentina	2801.8	3189.6	3612.4	3974.9
35. Mexico	5717.1	9197.0	14932.8	23267.3
36. Other Latin America	4554.0	5149.9	5883.7	6408.6
39. India	1289.8	1681.4	2147.2	2666.3
40-43. Other South Asia	963.1	1369.4	1926.8	2597.4
44. Indonesia	847.3	1215.9	1736.6	2431.6
45. Malaysia	1063.9	1724.3	2758.7	4325.3
46. Philippines	803.0	1308.6	2148.2	3422.6
47. Thailand	964.5	1810.0	3390.4	6211.6
48. Singapore	159.8	171.5	182.0	191.4
49. Hong Kong	190.5	230.7	267.7	297.1
50-52. Korea and Others	692.4	941.7	1288.9	1735.1
53-54. Oil producing	3807.8	4607.6	5619.1	6671.6
55. Other M.E. + N. Africa	2313.7	2931.6	3697.4	4579.4
56-58. Other Africa	5668.3	7341.4	9439.0	11961.9

Table A.15. Projections of passenger cars in use (in thousands) by broad regions, for 5 scenarios (see text).

		scenario	1985	1990	1995	2000
I.	North America	a	138388.8	146376.5	155649.1	162784.3
		b	141970.7	154439.5	164142.0	170215.8
		c	144551.4	160441.2	174527.8	183046.7
		d	147115.3	166076.7	178281.1	184757.1
		e	148179.3	171195.5	188866.8	198040.5
II.	Asia, developed	a	29708.5	36252.7	39537.4	40645.7
		b	30553.5	37831.5	39983.2	40705.3
		c	29697.9	39132.9	43436.1	44505.6
		d	30435.9	40637.0	43716.7	44522.2
		e	30859.2	43245.6	47408.3	48337.4
III.	Oceania, developed	a	8254.5	9612.3	10894.9	11776.0
		b	8440.2	10289.5	11699.0	12376.3
		c	8432.3	10492.1	12392.2	13399.5
		d	8602.5	11089.6	12904.0	13616.7
		e	8633.8	11389.0	13670.2	14602.8
IV.	North-West Europe	a	82466.4	87521.8	90701.0	92697.7
		b	83503.0	89530.0	93391.5	96016.0
		c	84988.4	92887.7	97835.7	101349.4
		d	86026.4	94607.5	100115.2	104171.6
		e	87605.5	98306.1	104934.3	109933.7
V.	South-West Europe	a	35084.9	39927.3	44361.6	47841.5
		b	36015.7	42662.3	48371.6	53387.8
		c	36195.4	43666.3	50255.6	55553.9
		d	37071.6	46002.5	53582.0	60870.6
		e	37237.1	46962.4	55257.9	62758.9
VI.	Eastern Europe	a	14825.8	18581.8	23234.2	28221.6
		b	15619.3	21234.1	28671.6	37537.4
		c	15619.3	21234.1	28671.6	37537.4
		d	16347.4	23410.4	33199.2	45597.9
		e	16347.4	23410.4	33199.2	45597.9
VII.	Latin America + Caribbean	a	20778.4	27951.9	38380.4	51786.6
		b	22341.1	33874.4	52616.3	80716.0
		c	22341.1	33874.4	52616.3	80716.0
		d	23829.2	39207.6	66406.9	111633.4
		e	23829.2	39207.6	66406.9	111633.4

Table A.15. (cont.)

	scenario	1985	1990	1995	2000
IX. South Asia	a	2252.9	3050.8	4074.0	5263.7
	b	2348.9	3394.6	4827.7	6643.4
	c	2348.9	3394.6	4827.7	6643.4
	d	2437.1	3676.3	5454.0	7834.0
	e	2437.1	3676.3	5454.0	7834.0
X. South-East + East Asia	a	4721.3	7402.7	11772.5	18614.7
	b	4888.6	8139.8	13791.0	23290.0
	c	4888.6	8139.8	13791.0	23290.0
	d	5042.3	8747.2	15490.2	27412.6
	e	5042.3	8747.2	15490.2	27412.6
XI. Middle-East + North Africa	a	6121.5	7539.2	9316.4	11251.0
	b	6428.2	8588.5	11530.6	15143.2
	c	6428.2	8588.5	11530.6	15143.2
	d	6656.4	9406.4	13387.6	18670.1
	e	6656.4	9406.4	13387.6	18670.1
XII. Other Africa	a	5668.3	7341.4	9439.0	11961.9
	b	5752.4	7593.8	9904.1	12678.2
	c	5752.4	7593.8	9904.1	12678.2
	d	5829.7	7801.3	10292.6	13300.6
	e	5829.7	7801.3	10292.6	13300.6
World, excl. Asian Centrally Planned Economies	a	348271.1	391558.3	437360.5	482844.7
	b	357861.6	417578.0	478928.7	548709.5
	c	361244.0	429445.4	499788.9	573863.3
	d	369393.7	450662.8	532829.4	632387.0
	e	372656.8	463348.0	554367.9	658122.0

Table A.16 Projections of discards of passenger cars (in thousands) for the standard scenario (see text).

	1985	1990	1995	2000
1. United States	9800.9	10791.0	10720.2	11669.4
2. Canada	863.7	1014.0	1093.9	1236.1
3. Japan	2485.6	3363.2	4263.1	4562.9
4-5. Australia + New Zealand	506.7	571.8	680.7	797.1
6. Germany F.R.	2200.2	2734.3	2796.4	2859.5
7. France	1647.4	1737.1	1827.4	1995.7
8. United Kingdom	1388.0	1368.5	1418.5	1429.1
9-14. N.W. Europe	1465.2	1554.3	1679.9	1744.0
15-18. N.W. Europe	469.8	597.3	6[illegible]1.8	726.1
19. Italy	1300.9	1382.5	1671.1	1646.8
20-25. S. Europe	777.6	1018.0	1091.7	1264.7
26-32. E. Europe	1032.1	1250.8	1368.5	1805.5
33-36. Latin America	976.3	1320.6	1501.4	2260.3
39-43. S. Asia	108.5	131.9	185.4	244.5
44-52. E. + S.E. Asia	167.1	265.7	407.6	651.4
53-54. Middle East + N. Africa (oil)	278.6	326.1	341.2	462.7
55-58. Other M.E. + Africa	334.7	424.2	591.6	773.4

Table A. 17. Projections of new registrations of passenger cars (in thousands) for the standard scenario (see text).

	1985	1990	1995	2000
1. United States	10214.2	12460.9	12221.7	12720.2
2. Canada	1113.6	1356.4	1388.4	1439.6
3. Japan	3802.6	4507.5	4660.3	4726.2
4-5. Australia + New Zealand	748.1	830.4	917.3	941.[illegible]
6. Germany F.R.	2722.0	2904.9	2808.5	2824.3
7. France	1868.4	2024.7	2125.7	2229.6
8. United Kingdom	1429.5	1425.4	1471.9	1469.0
9-14. N.W. Europe	1684.6	1739.4	1795.4	1810.2
15-18. N.W. Europe	672.2	745.3	753.6	762.0
19. Italy	1774.1	1923.2	2041.7	2058.7
20-25. S. Europe	1172.3	1444.8	1557.1	1712.5
26-32. E. Europe	1606.9	2066.3	2379.2	2880.6
33-36. Latin America	1969.0	2961.5	3997.0	5337.6
39-43. S. Asia	235.0	307.8	410.9	504.5
44-52. E. + S.E. Asia	548.5	912.3	1465.5	2302.7
53-54. Middle East + N. Africa (oil)	390.3	499.4	560.8	669.0
55-58. Other M.E. + Africa	717.5	934.4	1216.4	1513.7

Table A. 18 Projections of discards of passenger cars (in thousands) for 5 scenarios (see text)

		1985	1990	1995	2000
I.	North America	10664.6	11805.0	11814.1	12965.5
		10657.2	11952.7	12504.6	13748.2
		10711.2	12231.7	12851.9	14618.8
		10712.7	12312.9	13365.0	15090.7
		10719.9	12394.1	13636.[illegible]	15972.6
II.	Asia, developed	2485.6	3363.2	4263.1	4562.9
		2488.4	3509.4	4485.6	4593.3
		2441.1	3384.7	4748.3	5081.7
		2443.2	3511.0	4969.3	5074.5
		2446.2	3590.1	5398.1	5572.2
III.	Oceania, developed	506.7	571.8	689.7	797.1
		506.8	575.6	716.2	870.0
		506.6	574.5	720.3	914.2
		506.7	578.0	752.7	978.8
		506.7	579.7	762.6	1026.6
IV.	North-West Europe	7170.6	7991.5	8404.0	8756.4
		7171.7	8053.0	8618.1	8986.6
		7176.6	8161.0	8966.0	9412.0
		7177.8	8219.6	9164.9	9591.7
		7182.5	8326.3	9546.5	10048.1
V.	South-West Europe	2078.5	2400.5	2762.8	3111.5
		2078.9	2413.0	2900.1	3408.2
		2079.0	2421.5	2935.2	3538.6
		2079.2	2436.9	3062.1	3757.9
		2079.3	2440.3	3097.3	3908.9
VI.	Eastern Europe	1032.1	1259.8	1369.5	1805.5
		1032.5	1269.9	1501.4	2140.3
		1032.5	1269.9	1501.4	2140.3
		1032.9	1285.8	1614.4	2415.2
		1032.9	1285.8	1614.4	2415.2

Table A.18 (cont.)

		1985	1990	1995	2000
VII.	Latin America + Caribbean	976.3	1320.6	1591.4	2260.1
		977.0	1346.7	1805.3	2935.5
		977.0	1346.7	1805.3	2935.5
		977.6	1369.2	1997.4	3558.4
		977.6	1369.2	1997.4	3558.4
IX.	South Asia	103.5	131.0	185.4	244.5
		108.5	133.0	195.3	277.0
		108.5	133.0	195.3	277.0
		108.5	134.0	203.7	304.0
		108.5	134.0	203.7	304.0
X.	South-East + East Asia	167.1	265.7	407.6	651.4
		167.1	268.4	431.7	738.8
		167.1	268.4	431.7	738.8
		167.2	270.6	452.2	811.5
		167.2	270.6	452.2	811.5
XI.	Middle-East + North Africa	278.6	326.1	341.2	462.7
		278.8	335.0	395.1	588.8
		278.8	335.0	395.1	588.8
		278.9	341.2	434.6	691.3
		278.9	341.2	434.6	691.3
XII.	Other Africa	334.7	434.2	591.6	773.4
		334.8	436.5	609.3	821.3
		334.8	436.5	609.3	821.3
		334.9	438.5	624.4	860.9
		334.9	438.5	624.4	860.9

Table A. 19 Projections of new registrations of passenger cars (in thousands) for 5 scenarios (see text)

		1985	1990	1995	2000
I.	North America	11328.0	13817.3	13610.1	14159.7
		12483.9	14598.3	14139.4	14836.0
		12716.0	15835.9	15231.0	16055.5
		13665.0	16042.1	15226.9	16232.1
		13928.2	17276.1	16398.3	17456.6
II.	Asia, developed	3802.6	4507.5	4660.3	4725.2
		4116.9	4548.9	4699.5	4713.5
		4047.2	5109.6	5174.3	5238.2
		4362.2	5082.6	5231.8	5216.5
		4540.8	5654.3	5735.7	5727.9
III.	Oceania, developed	748.1	850.4	917.3	941.0
		819.4	948.6	935.4	977.5
		825.4	1020.0	1037.3	1060.5
		896.3	1087.1	1010.7	1078.6
		910.3	1171.9	1100.9	1151.5
IV.	North-West Europe	8376.9	8839.7	8955.1	9094.5
		8663.0	9047.3	9310.3	9433.9
		9062.9	9459.0	9847.3	10032.5
		9374.4	9589.3	10178.4	10299.5
		9835.1	10014.0	10763.1	10930.9
V.	South-West Europe	2946.4	3368.0	3598.8	3771.3
		3232.0	3712.4	3982.6	4436.8
		3300.3	3933.5	4146.4	4592.2
		3600.0	4154.5	4520.2	5352.4
		3662.8	4371.2	4645.5	5498.5
VI.	Eastern Europe	1606.9	2066.3	2379.2	2880.6
		1806.9	2521.3	3159.6	4101.2
		1806.9	2521.3	3159.6	4101.2
		2014.7	2987.3	3834.7	5205.1
		2014.7	2887.3	3834.7	5205.1

Table A. 19 (cont.)

	1985	1990	1995	2000
VII. Latin America + Caribbean	1969.0	2961.5	3997.0	5337.[illegible]
	2379.8	4093.8	6325.0	9692.[illegible]
	2379.8	4093.8	6325.0	9692.[illegible]
	2829.0	5143.8	8769.5	14800.5
	2829.0	5143.8	8769.[illegible]	14800.[illegible]
IX. South Asia	235.8	307.8	410.9	504.5
	260.9	369.3	519.3	684.6
	260.9	369.3	519.3	684.6
	286.9	418.7	612.7	847.8
	286.9	418.7	612.7	847.8
X. South-East + East Asia	548.5	912.3	1465.5	2302.7
	597.2	1069.8	1831.9	3086.[illegible]
	597.2	1069.8	1831.9	3086.[illegible]
	646.7	1198.1	2150.6	3808.0
	646.7	1198.1	2150.6	3808.0
XI. Middle-East + North Africa	390.[illegible]	499.4	560.8	689.0
	454.5	651.5	835.1	1121.5
	454.5	651.5	835.1	1121.5
	504.7	777.5	1082.6	1549.2
	504.7	777.5	1082.6	1549.2
XII. Other Africa	717.5	934.4	1216.4	1513.7
	751.1	1007.0	1335.3	1697.7
	751.1	1007.0	1335.3	1697.7
	786.3	1065.3	1438.4	1865.2
	786.3	1065.3	1438.4	1865.2

Table A.20 Commercial vehicles in use, 1950–1975
(in thousands)

		1950	1955	1960	1965	1970	1975
1	United States	8,828	10,558	12,210	15,015	19,127	26,243
2	Canada	650	977	1,117	1,345	1,738	2,543
3	Japan	251	710	1,383	4,298	8,740	10,315
4	Australia	499	650	838	874	972	1,200
5	New Zealand	82	115	125	159	182	206
6	Germany, Fed.Rep. of	552	635	728	865	1,002	1,341
7	France	406	662	909	1,213	1,615	2,134
8	United Kingdom	–	1,208	1,519	1,791	1,754	1,911
9–10	Benelux	230	252	362	482	573	647
11	Denmark	61	103	170	244	257	239
12	Iceland	4	5	6	6	6	7
13	Sweden	86	108	115	141	159	171
14	Switzerland	40	54	61	93	141	179
15	Ireland	27	42	46	51	53	58
16	Norway	52	85	113	132	152	147
17	Finland	33	55	73	88	111	137
18	Austria	47	121	204	299	408	446
19	Italy	229	367	459	666	930	1,140
20	Spain	83	102	149	387	741	1,040
21	Portugal	29	40	50	89	132	193
22	Greece	21	27	37	73	117	211
23	Turkey	19	41	68	101	160	271
24	Yugoslavia	6	13	39	67	122	179
25	Other Western Europe	–	–	5	7	11	13
26–32	Eastern Europe + USSR	–	–	3,520	4,220	5,270	6,150
33	Brazil	100	181	335	517	696	1,063
34	Argentina	239	260	390	571	755	874
35	Mexico	130	242	315	389	589	888
36	Other Latin America	325	563	644	898	n.a.	n.a.
37–38	Asia, Centrally Planned	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
39	India	113	157	246	376	414	434
40–43	South Asia, excl. India	n.a.	n.a.	176[a]	234[a]	284[a]	332[a]
41	Pakistan	14	20	30	45	64	70
42	Sri Lanka	14	22	31	36	45	49
44	Indonesia	29	55	92	103	126	232
45	Malaysia	15	22	34	52	73	114
46	Philippines	55	63	75	130	179	272
47	Thailand	13	28	50	76	163	234
48	Singapore	7	11	15	23	38	46
49	Hong Kong	4	4	10	20	29	44
50	Korea, Rep. of	n.a.	11	19	25	65	100
53	Iran	18	24	44	48	74	189
53–54	Oil producing Arab. + Israël	n.a.	n.a.	152[a]	250[a]	411[a]	711[a]
55	Other M.E. + N. Africa	n.a.	n.a.	212[a]	250[a]	314[a]	411[a]
56	Nigeria	n.a.	n.a.	20	26	40	86
57	South Africa	112	146	198	315	428	800
56–58	Other Africa	n.a.	n.a.	675[a]	975[a]	1,434[a]	1,836[a]

Note: a) Own estimates.

Table A.21 Projections of commercial vehicles in use, for three economic scenarios.

		scenario	1985	1990	1995	2000
1.	United States	G1	32490.5	36028.6	39840.2	42550.3
		G2	35303.4	43043.1	52015.6	60597.3
		G3	37250.6	48200.4	61522.6	75563.9
2.	Canada	G1	3853.9	4325.6	4876.5	5417.8
		G2	3957.1	4713.8	5695.6	6793.1
		G3	4047.0	5032.9	6368.8	7960.1
3.	Japan	G1	17866.2	23004.3	29407.3	36429.6
		G2	18784.8	26154.7	36017.3	47995.6
		G3	19627.9	28738.8	41517.3	57994.5
4.	Australia	G1	1581.9	1747.0	1942.4	2150.5
		G2	1607.1	1845.7	2158.9	2529.9
		G3	1629.3	1927.4	2338.3	2854.5
5.	New Zealand	G1	187.9	175.8	171.2	158.4
		G2	203.2	236.2	294.4	355.9
		G3	217.6	286.8	396.9	525.6
6.	Germany, F.R.	G1	1629.0	1815.7	2041.2	2273.6
		G2	1667.9	1951.0	2320.4	2746.7
		G3	1703.0	2062.5	2552.4	3154.7
7.	France	G1	2696.1	3140.8	3674.5	4208.1
		G2	2782.1	3478.8	4386.6	5410.9
		G3	2871.0	3771.8	4993.7	6464.5
8.	United Kingdom	G1	2117.1	2260.3	2414.5	2524.2
		G2	2231.0	2544.2	2907.3	3254.6
		G3	2309.8	2752.9	3292.0	3860.2
9-10.	Benelux	G1	719.3	769.4	824.1	872.7
		G2	735.1	816.4	909.5	1002.6
		G3	749.5	853.8	976.7	1106.7
11.	Denmark	G1	294.1	296.5	298.9	300.8
		G2	295.1	299.6	305.1	310.6
		G3	295.9	302.3	310.3	319.0
12.	Iceland	G1	8.4	8.8	9.3	9.7
		G2	8.5	9.2	10.1	11.1
		G3	8.6	9.5	10.7	12.2
13.	Sweden	G1	213.2	236.9	265.2	293.3
		G2	218.7	256.1	304.5	358.9
		G3	223.6	272.0	337.2	415.4

Table A.21 (cont.)

	scenario	1985	1990	1995	2000
14. Switzerland	G1	232.0	286.9	350.3	405.7
	G2	251.9	353.4	480.1	612.1
	G3	269.6	408.3	588.0	790.1
15. Ireland	G1	64.1	69.6	76.2	83.1
	G2	65.2	73.4	84.3	96.9
	G3	66.1	76.6	91.0	108.7
16. Norway	G1	216.1	272.7	341.6	414.3
	G2	229.0	313.2	423.2	552.7
	G3	239.6	345.1	489.6	670.5
17. Finland	G1	194.0	237.2	292.4	355.9
	G2	199.2	258.3	341.0	445.3
	G3	203.7	275.8	381.3	521.6
18. Austria	G1	487.1	497.9	510.5	522.6
	G2	490.1	507.7	529.6	553.6
	G3	492.9	515.7	545.4	580.5
19. Italy	G1	1515.2	1753.7	2046.3	2349.2
	G2	1559.8	1925.9	2418.3	2988.7
	G3	1599.2	2068.8	2726.9	3536.1
20. Spain	G1	1305.8	1392.3	1483.1	1530.4
	G2	1382.8	1615.6	1878.9	2114.9
	G3	1453.5	1799.2	2209.8	2623.6
21. Portugal	G1	326.3	374.3	430.3	488.5
	G2	334.3	405.7	499.1	607.7
	G3	341.3	431.8	556.2	709.6
22. Greece	G1	315.6	338.2	362.6	379.9
	G2	328.9	377.6	434.1	488.1
	G3	341.1	410.0	493.9	582.3
23. Turkey	G1	391.3	423.5	457.9	487.1
	G2	402.6	464.4	540.9	620.3
	G3	412.5	498.5	609.9	734.6
24. Yugoslavia	G1	349.0	444.5	566.3	705.4
	G2	361.1	492.9	676.2	905.9
	G3	371.8	532.9	767.2	1077.4
25. Other West Europe	G1	121.8	128.3	135.8	143.0
	G2	123.6	134.1	147.1	161.4
	G3	126.1	140.0	158.0	179.3
26-32. Eastern Europe	G1	8388.6	9458.6	10634.8	11851.0
	G2	8483.8	9776.8	11287.1	12968.6
	G3	8571.2	10037.9	11830.3	13935.7
33. Brazil	G1	1715.7	2229.3	2889.3	3673.1
	G2	1762.1	2419.9	3338.5	4527.3
	G3	1803.1	2577.3	3710.1	5257.8

Table A.21 (cont. 2).

		scenario	1985	1990	1995	2000
34.	Argentina	G1	934.8	1001.0	1091.8	1169.8
		G2	967.1	1116.3	1323.0	1538.6
		G3	995.6	1212.2	1515.1	1855.3
35.	Mexico	G1	1610.4	2009.5	2561.0	3271.8
		G2	1642.1	2149.9	2913.3	3980.5
		G3	1670.0	2265.9	3204.4	4584.3
36.	Other Latin America	G1	1930.5	2163.0	2432.7	2682.3
		G2	2000.7	2396.0	2891.0	3422.8
		G3	2063.9	2588.0	3272.4	4062.3
39.	India	G1	929.9	1148.5	1434.1	1770.1
		G2	961.0	1260.2	1679.7	2220.7
		G3	989.5	1351.7	1883.7	2609.4
40-43.	Other South Asia	G1	542.8	723.8	960.4	1238.8
		G2	569.2	818.0	1166.6	1616.1
		G3	593.4	895.2	1338.0	1941.6
44-52.	S.E. + E. Asia	G1	2465.3	3393.4	4661.6	6245.0
		G2	2577.0	3810.6	5616.9	8072.5
		G3	2679.3	4152.2	6409.7	9646.9
53-54.	Oil producing	G1	1246.3	1445.7	1684.9	1929.2
		G2	1294.1	1601.5	1996.4	2449.5
		G3	1327.3	1716.1	2239.5	2880.2
55.	Other M.E. + N.Africa	G1	1618.3	2622.4	3934.7	5478.4
		G2	1761.1	3135.4	5062.8	7548.2
		G3	1892.1	3555.8	6000.2	9334.1
56-58.	Other Africa	G1	2238.7	2535.7	2869.9	3143.8
		G2	2386.1	2978.0	3684.8	4398.8
		G3	2521.4	3341.6	4365.5	5489.5

Table A.22 Projections of discards of commercial vehicles (in thousands) for three scenarios (see text)

			1985	1990	1995	2000
1.	United States	G1	1934.3	2412.4	2240.9	2258.5
		G2	1935.6	2449.1	2462.6	2922.3
		G3	1936.1	2461.4	2600.7	3242.4
2.	Canada	G1	170.6	249.8	269.7	270.7
		G2	170.6	250.6	277.7	301.4
		G3	170.6	251.3	284.4	326.9
3.	Japan	G1	1649.0	2234.5	2603.6	3305.1
		G2	1650.0	2303.7	2890.5	3933.1
		G3	1651.0	2361.8	3148.7	4447.7
4-5.	Australia + New Zealand	G1	106.5	126.5	127.2	135.7
		G2	106.5	126.9	131.3	150.6
		G3	106.5	127.3	134.9	163.2
6.	Germany F.R.	G1	184.6	174.9	197.7	213.7
		G2	184.7	175.5	202.8	228.6
		G3	184.7	176.0	207.1	240.9
7.	France	G1	219.4	252.9	261.0	302.6
		G2	219.4	254.0	272.5	340.4
		G3	219.4	255.2	283.5	372.9
8.	United Kingdom	G1	257.3	253.1	253.2	272.0
		G2	257.4	255.8	267.3	300.6
		G3	257.5	257.0	276.5	322.9
9-14.	N.W. Europe	G1	134.3	140.6	145.0	157.9
		G2	134.4	141.2	150.4	172.7
		G3	134.4	141.8	154.9	134.7

Table A.22 (cont.)

			1985	1990	1995	2000
15-18.	S.W. Europe	G1	53.9	55.7	64.9	74.6
		G2	53.9	56.1	67.8	82.9
		G3	53.9	56.4	70.2	89.6
19.	Italy	G1	87.5	100.4	117.0	137.7
		G2	87.5	101.3	124.5	160.3
		G3	87.5	102.1	131.4	179.0
20-25.	S. Europe	G1	172.4	215.2	216.4	246.1
		G2	172.5	[illegible]	236.5	293.9
		G3	172.6	220.4	253.8	333.4
26-32.	E. Europe	G1	669.7	749.7	762.5	882.1
		G2	669.7	751.3	795.0	916.9
		G3	669.8	752.7	815.5	945.7
33-36.	Latin America	G1	328.8	393.6	440.8	531.4
		G2	328.9	395.5	459.2	595.7
		G3	328.9	397.1	474.9	649.4
39-43.	S. Asia	G1	44.7	68.3	96.5	118.1
		G2	44.7	69.0	102.5	137.6
		G3	44.7	69.6	107.5	153.7
44-52.	E. + S.E. Asia	G1	97.6	160.6	193.9	257.4
		G2	97.7	161.9	205.6	297.2
		G3	97.7	163.0	215.5	330.1
53-54.	Middle-East + N. Africa (oil)	G1	71.5	98.9	92.7	111.8
		G2	71.5	99.7	98.9	126.7
		G3	71.6	100.2	103.2	141.4
55-58.	Other M.E. + Africa	G1	156.7	201.2	274.9	370.6
		G2	156.8	204.0	304.3	460.2
		G3	156.9	227.7	329.2	534.7

Table A.23 Projections of new registrations of commercial vehicles (in thousands) for three scenarios (see text)

			1985	1990	1995	2000
1.	United States	G1	2162.1	3141.3	3026.1	2811.4
		G2	2653.7	4085.8	4364.7	4624.4
		G3	3168.0	4826.5	5478.1	5247.1
2.	Canada	G1	251.7	351.2	365.7	378.1
		G2	284.1	421.9	490.8	530.2
		G3	315.3	477.3	579.5	656.8
3.	Japan	G1	2451.7	3394.5	3999.4	4921.8
		G2	2688.2	3954.2	5208.3	6591.9
		G3	2933.0	4438.5	6061.4	8170.6
4-5.	Australia + New Zealand	G1	131.9	160.2	168.4	175.3
		G2	145.2	189.6	213.5	242.7
		G3	158.1	213.2	252.0	303.5
6.	Germany F.R.	G1	213.9	215.5	246.0	262.1
		G2	224.7	239.1	284.1	320.5
		G3	235.8	257.9	316.9	373.5
7.	France	G1	288.9	350.0	374.3	411.3
		G2	317.2	411.7	470.5	557.7
		G3	346.3	461.6	555.1	692.0
8.	United Kingdom	G1	265.6	282.6	295.0	294.3
		G2	286.5	322.1	344.3	373.6
		G3	307.3	352.7	393.6	444.5
9-14.	N.W. Europe	G1	154.6	166.5	176.1	185.0
		G2	165.8	190.7	209.0	232.4
		G3	177.2	206.0	236.5	274.3

Table A.23 (cont).

			1985	1990	1995	2000
15-18.	S.W.Europe	G1	72.3	81.0	96.0	107.6
		G2	78.0	94.2	116.0	142.1
		G3	83.8	104.6	136.8	173.1
19.	Italy	G1	125.6	153.0	179.3	199.1
		G2	139.7	185.6	232.8	281.0
		G3	153.4	221.6	278.3	354.2
20-25.	S. Europe	G1	223.5	276.7	287.1	307.3
		G2	255.0	339.7	384.6	446.7
		G3	287.3	390.3	469.2	573.3
26-32.	E. Europe	G1	862.9	971.5	1027.4	1134.7
		G2	886.9	1025.4	1117.6	1275.8
		G3	911.8	1068.7	1195.6	1404.9
33-36.	Latin America	G1	518.0	664.5	786.2	922.2
		G2	572.2	790.2	995.5	1258.5
		G3	625.9	890.6	1173.8	1561.5
39-43.	S. Asia	G1	106.6	157.0	212.5	253.3
		G2	121.6	193.9	277.6	361.4
		G3	137.2	223.5	333.6	459.4
44-52.	E. + S.E. Asia	G1	239.6	370.1	460.2	611.9
		G2	269.5	447.6	624.1	861.5
		G3	300.3	509.9	747.4	1086.7
53-54.	Middle-East + N. Africa (oil)	G1	102.2	141.7	144.1	163.9
		G2	114.1	167.4	186.0	227.9
		G3	123.2	187.5	220.7	284.1
55-58.	Other M.E. + Africa	G1	352.1	480.3	636.3	767.4
		G2	424.2	644.9	895.3	1174.0
		G3	499.5	772.3	1119.5	1544.9

Table A.24 Average number of tires per new passenger car

		1980	1985	1990	1995	2000
1	United States	5	5	4.9	4.8	4.8
2	Canada	5	5	4.9	4.9	4.8
3	Japan	5	5	4.9	4.8	4.7
4-5	Australia and New Zealand	5	5	5	5	4.9
6	Germany, Fed.Rep. of	5	5	4.9	4.8	4.7
7	France	5	5	4.9	4.8	4.7
8	United Kingdom	5	5	4.9	4.8	4.7
9-14	Northern Europe I	5	5	4.9	4.8	4.7
15-18	Northern Europe II	5	5	4.9	4.8	4.7
19	Italy	5	5	5	4.9	4.8
20-25	Southern Europe	5	5	5	5	4.9
26-32	Eastern Europe	5	5	5	5	5
33-58	Rest of the world	5	5	5	5	5

Table A.25 Share of radial tires in tire market.

Countries			1965	1970	1975
U.S.A.[a]	pass.cars	O.E.	0	1.2	64.5
		Rep.	0.3	3.5	30.4
	com. veh.	O.E.	0	10.0	35.0
Japan[b]	pass.cars	Total	0	11.8	45.1
W. Germany[c]	pass.cars	Rep.	0	45.0	82.0
	light c.v.	Rep.	0	32.0	79.0
	heavy c.v.	Rep.	0	36.0	72.0
France[d]	pass.cars	Total	70.0	80.0	100.0
	com. veh.	Total	70.0	90.0	100.0
U.K.[e]	pass.cars	O.E.	0	34.2	90.5
		Rep.	0	36.9	64.0
	com. veh.	Total	10.0	35.0	70.0
Benelux[d]	pass.cars	Total	40.0	50.0	80.0
	com. veh.	Total	30.0	45.0	80.0
Italy[d]	pass.cars	Total	35.0	50.0	90.0
	com. veh.	Total	25.0	50.0	85.0
Spain[d]	pass.cars	Total	30.0	60.0	90.0
	com. veh.	Total	30.0	55.0	80.0

Notes:
a) USA-industry: auto tire sales.
b) Japan Automobile Tire Manufacturer Association
c) Rubber Trends, March 1976.
d) Euro-economics.
e) Rubber Statistical Bulletin

O.E. = original equipment
Rep. = replacement

Table A.26 Projections of demand for original equipment tires (in thousands) for passenger cars

		code	scenario	1985	1990	1995	2000
I.	North America	C	a	5664.	3385.	0.	0.
			b	6242.	3577.	0.	0.
			c	6358.	3880.	0.	0.
			d	6833.	3930.	0.	0.
			e	6964.	4233.	0.	0.
		R	a	50976.	64320.	65467.	67967.
			b	56178.	67955.	68009.	71213.
			c	57222.	73716.	73260.	77066.
			d	61492.	74676.	73237.	77914.
			e	62677.	80420.	78871.	83792.
		T	a	56640.	67705.	65467.	67967.
			b	62420.	71532.	68009.	71213.
			c	63580.	77596.	73260.	77066.
			d	68325.	78606.	73237.	77914.
			e	69641.	84653.	78871.	83792.
II.	Asia, developed	C	a	2747.	1065.	0.	0.
			b	2982.	1068.	0.	0.
			c	2939.	1205.	0.	0.
			d	3175.	1192.	0.	0.
			e	3308.	1328.	0.	0.
		R	a	15565.	20239.	21262.	21154.
			b	16898.	20287.	21489.	21040.
			c	16653.	22903.	23497.	23406.
			d	17989.	22645.	23827.	23218.
			e	18745.	25226.	25986.	25490.
		T	a	18312.	21304.	21262.	21154.
			b	19880.	21355.	21489.	21040.
			c	19592.	24108.	23497.	23406.
			d	21164.	23837.	23827.	23218.
			e	22053.	26554.	25986.	25490.
III.	Oceania, developed	C	a	748.	213.	0.	0.
			b	819.	237.	0.	0.
			c	825.	255.	0.	0.
			d	896.	272.	0.	0.
			e	910.	293.	0.	0.
		R	a	2992.	4039.	4587.	4611.
			b	3278.	4506.	4677.	4790.
			c	3302.	4845.	5187.	5196.
			d	3585.	5164.	5054.	5285.
			e	3641.	5567.	5505.	5642.
		T	a	3741.	4252.	4587.	4611.
			b	4097.	4743.	4677.	4790.
			c	4127.	5100.	5187.	5196.
			d	4482.	5436.	5054.	5285.
			e	4552.	5860.	5505.	5642.

Table A.26 (cont. 1)

	code	scenario	1985	1990	1995	2000
IV. North-West Europe	C	a	1270.	0.	0.	0.
		b	1317.	0.	0.	0.
		c	1418.	0.	0.	0.
		d	1473.	0.	0.	0.
		e	1586.	0.	0.	0.
	R	a	40615.	43315.	42984.	42744.
		b	41998.	44332.	44689.	44339.
		c	43896.	46353.	47267.	47153.
		d	45399.	46988.	48856.	48408.
		e	47590.	49069.	51663.	51375.
	T	a	41885.	43315.	42984.	42744.
		b	43315.	44332.	44689.	44339.
		c	45314.	46353.	47267.	47153.
		d	46872.	46988.	48856.	48408.
		e	49175.	49069.	51663.	51375.
V. South-West Europe	C	a	293.	0.	0.	0.
		b	322.	0.	0.	0.
		c	321.	0.	0.	0.
		d	351.	0.	0.	0.
		e	351.	0.	0.	0.
	R	a	14439.	16840.	17790.	18274.
		b	15941.	18562.	19713.	21530.
		c	16180.	19668.	20513.	22273.
		d	17649.	20823.	22387.	25993.
		e	17963.	21857.	23002.	26695.
	T	a	14732.	16840.	17790.	18274.
		b	16163.	18562.	19713.	21530.
		c	16502.	19668.	20513.	22273.
		d	18000.	20823.	22387.	25993.
		e	18314.	21857.	23002.	26695.
VI. Eastern Europe	C	a	3214.	2066.	1190.	706.
		b	3614.	2521.	1580.	1005.
		c	3614.	2521.	1580.	1005.
		d	4029.	2887.	1917.	1275.
		e	4029.	2887.	1917.	1275.
	R	a	4821.	8265.	10706.	13409.
		b	5421.	10085.	14218.	19091.
		c	5421.	10085.	14218.	19091.
		d	6044.	11549.	17256.	24230.
		e	6044.	11549.	17256.	24230.
	T	a	8035.	10332.	11896.	14115.
		b	9034.	12607.	15798.	20096.
		c	9034.	12607.	15798.	20096.
		d	10074.	14437.	19174.	25505.
		e	10074.	14437.	19174.	25505.

Table A.26 (cont. 2).

		code	scenario	1985	1990	1995	2000
VII.	Latin America + Caribbean	C	a	3938.	2962.	1999.	1334.
			b	4760.	4094.	3163.	2423.
			c	4760.	4094.	3163.	2423.
			d	5658.	5144.	4385.	3700.
			e	5658.	5144.	4385.	3700.
		R	a	5907.	11846.	17987.	25364.
			b	7139.	16375.	28463.	46040.
			c	7139.	16375.	28463.	46040.
			d	8487.	20575.	39463.	70303.
			e	8487.	20575.	39463.	70303.
		T	a	9845.	14808.	19985.	26688.
			b	11899.	20469.	31625.	48463.
			c	11899.	20469.	31625.	48463.
			d	14145.	25719.	43848.	74003.
			e	14145.	25719.	43848.	74003.
IX.	South Asia	C	a	707.	616.	616.	504.
			b	783.	739.	779.	685.
			c	783.	739.	779.	685.
			d	861.	837.	919.	848.
			e	861.	837.	919.	848.
		R	a	472.	923.	1438.	2018.
			b	522.	1108.	1818.	2738.
			c	522.	1108.	1819.	2738.
			d	574.	1256.	2144.	3391.
			e	574.	1256.	2144.	3391.
		T	a	1179.	1539.	2055.	2523.
			b	1305.	1847.	2597.	3423.
			c	1305.	1847.	2597.	3423.
			d	1435.	2094.	3064.	4239.
			e	1435.	2094.	3064.	4239.
X.	South-East + East Asia	C	a	823.	456.	366.	0.
			b	896.	535.	458.	0.
			c	896.	535.	458.	0.
			d	970.	599.	538.	0.
			e	970.	599.	538.	0.
		R	a	1920.	4105.	6961.	11514.
			b	2090.	4814.	8702.	15430.
			c	2090.	4814.	8702.	15430.
			d	2263.	5391.	10215.	19040.
			e	2263.	5391.	10215.	19040.
		T	a	2743.	4562.	7327.	11514.
			b	2986.	5349.	9159.	15430.
			c	2986.	5349.	9159.	15430.
			d	3234.	5991.	10753.	19040.
			e	3234.	5991.	10753.	19040.

Table A.26 (cont. 3)

	code	scenario	1985	1990	1995	2000
XI. Middle East + North Africa	C	a	586.	250.	140.	0.
		b	682.	326.	209.	0.
		c	682.	326.	209.	0.
		d	757.	389.	271.	0.
		e	757.	389.	271.	0.
	R	a	1368.	2247.	2664.	3376.
		b	1591.	2932.	3967.	5495.
		c	1591.	2932.	3967.	5495.
		d	1766.	3499.	5142.	7591.
		e	1766.	3499.	5142.	7591.
	T	a	1954.	2497.	2804.	3376.
		b	2273.	3258.	4176.	5495.
		c	2273.	3258.	4176.	5495.
		d	2524.	3888.	5413.	7591.
		e	2524.	3888.	5413.	7591.
XII. Other Africa	C	a	2152.	1862.	1824.	1512.
		b	2254.	2014.	2003.	1698.
		c	2254.	2014.	2003.	1698.
		d	2359.	2131.	2158.	1865.
		e	2359.	2131.	2158.	1865.
	R	a	1435.	2794.	4256.	6049.
		b	1502.	3022.	4675.	6792.
		c	1502.	3022.	4675.	6792.
		d	1573.	3197.	5035.	7462.
		e	1573.	3197.	5035.	7462.
	T	a	3587.	4656.	6080.	7561.
		b	3756.	5036.	6678.	8489.
		c	3756.	5036.	6678.	8489.
		d	3932.	5328.	7193.	9327.
		e	3932.	5328.	7193.	9327.
World total (excl. Asian CPE countries)	C	a	22142.	12875.	6135.	4057.
		b	24669.	15110.	8191.	5910.
		c	24849.	15569.	9191.	5810.
		d	27361.	17381.	10188.	7689.
		e	27753.	17841.	10188.	7689.
	R	a	140509.	178933.	196102.	216468.
		b	152457.	193978.	220418.	258498.
		c	155519.	205820.	231565.	270681.
		d	166822.	215762.	252618.	312834.
		e	171323.	227605.	264284.	325010.
	T	a	162651.	191808.	202237.	220525.
		b	177127.	209088.	228609.	264309.
		c	180368.	221389.	239756.	275492.
		d	194184.	233143.	262806.	320522.
		e	199076.	245446.	274471.	332699.

Notes: C = conventional tires
R = radial tires
T = total tires

Table A.27 Percentage distribution of commercial vehicles in use: load capacity

Year	West Germany				France				Austria			
	less than 1,000 kg	less than 1,500 kg	less than 3,000 kg	less than 5,000 kg	less than 1,000 kg	less than 1,500 kg	less than 3,000 kg	less than 5,000 kg*	less than 1,000 kg	less than 1,500 kg	less than 3,000 kg	less than 5,000 kg
1955	40.4	-	67.1	89.3	43.5	-	79.8	88.6	34.6	-	65.5	94.8
1956	42.2	-	70.0	91.2	43.8	-	80.4	88.5	36.5	-	65.0	94.2
1957	41.2	-	69.4	90.6	44.3	-	80.9	88.4	37.0	-	64.5	92.9
1958	40.4	-	69.6	90.3	45.2	-	81.5	88.5	37.1	-	63.5	91.7
1959	38.9	-	68.9	88.7	46.2	-	82.1	88.6	37.0	-	62.2	89.9
1960	38.1	-	68.2	86.7	47.4	-	82.6	88.6	36.4	-	60.8	87.6
1961	37.2	-	67.7	85.0	48.1	-	82.9	88.4	36.6	-	60.2	85.2
1962	37.0	-	67.7	83.7	48.9	-	83.2	88.4	37.0	-	60.2	82.9
1963	35.9	-	66.6	81.8	49.5	-	83.3	88.2	36.8	-	59.9	81.1
1964	34.6	-	65.9	80.5	50.0	-	83.2	87.8	35.0	-	58.7	79.5
1965	32.8	-	66.0	79.9	50.2	-	83.1	87.9	33.6	-	58.5	77.7
1966	30.6	-	65.9	79.6	50.1	-	83.0	87.7	32.6	-	58.8	76.5
1967	28.5	-	66.1	79.7	50.1	-	83.0	87.6	31.2	-	58.5	75.1
1968	-	43.5	66.3	79.9	-	67.6	-	72.9	-	45.9	59.4	75.0
1969	-	43.4	66.3	799	-	68.4	-	73.7	-	46.8	59.9	74.5
1970	-	43.1	65.9	79.6	-	68.6	-	74.0	-	48.7	61.1	74.6
1971	-	42.3	64.9	78.9	-	69.4	-	74.7	-	49.8	61.7	74.2
1972	-	42.2	64.4	78.7	-	69.9	-	75.1	-	50.5	61.8	73.4
1973	-	42.7	64.4	78.9	-	73.0	-	77.4	-	51.3	62.1	73.0
1974	-	43.1	64.3	79.0	-	73.3	-	77.6	-	51.8	62.4	72.9
1975	-	43.9	64.7	79.5	-	73.6	-	77.7	-	52.2	62.7	72.8

* from 1968 series not comparable.

Table A.27 (continued)

Year	Denmark				Italy			
	less than 1,000 kg	less than 1,500 kg	less than 3,000 kg	less than 5,000 kg	less than 1,000 kg	less than 1,500 kg	less than 3,000 kg	less than 5,000 kg
1955	56.2	-	74.0	91.7	54.1	-	81.5	91.9
1956	59.4	-	74.5	91.6	59.2	-	81.4	91.9
1957	62.3	-	76.0	91.1	57.0	-	80.1	89.7
1958	65.0	-	77.8	90.9	57.6	-	80.6	89.9
1959	67.9	-	79.9	90.5	59.0	-	81.4	89.8
1960	69.7	-	81.2	90.1	59.4	-	80.6	89.2
1961	71.1	-	82.4	89.9	59.3	-	78.9	87.8
1962	71.9	-	83.0	89.5	59.7	-	79.1	87.9
1963	72.1	-	83.6	89.4	58.3	-	78.5	87.6
1964	71.6	-	84.2	89.1	37.4	-	78.7	87.7
1965	69.3	-	83.9	88.7	39.2	-	78.8	87.7
1966	68.1	-	84.2	88.6	39.1	-	78.0	87.2
1967	66.8	-	84.6	88.8	38.3	-	78.4	87.5
1968	-	80.0	84.5	88.5	-	-	-	-
1969	-	79.2	84.2	88.0	-	-	-	-
1970	-	76.0	83.2	87.0	-	-	-	-
1971	-	70.8	80.9	85.1	-	-	-	-
1972	-	67.4	79.1	83.6	-	67.9	80.6	90.2
1973	-	69.0	80.5	84.7	-	67.9	80.9	90.3
1974	-	69.6	81.4	85.4	-	67.5	80.9	90.3
1975	-	70.8	82.6	86.4	-	-	-	-

Source: United Nations Annual Bulletin of Transport Statistics for Europe 1975-1953

Table A.28 Commercial vehicle production by weight groups.

Year	West Germany			France			Italy		
	less than 4,000 kg	less than 6,000 kg	less than 12,000 kg	less than 4,000 kg	less than 6,000 kg	less than 12,000 kg	less than 4,000 kg	less than 6,000 kg	less than 12,000 kg
1961	58.0	62.5	76.7	-	-	-	36.9	41.4	78.9
1962	58.7	63.9	76.5	-	-	-	39.5	44.2	82.1
1963	58.4	64.4	76.8	80.3	87.5	92.5	40.9	49.2	74.5
1964	60.7	65.8	77.0	79.7	86.2	91.3	47.8	57.0	81.1
1965	59.0	65.9	76.8	82.2	88.4	92.7	56.0	72.0	90.6
1966	54.8	63.0	74.9	82.8	88.8	93.2	56.9	69.2	84.8
1967	57.2	64.9	76.5	83.4	88.9	93.1	53.7	65.6	81.2
1968	55.5	64.5	76.2	83.1	88.8	92.8	52.7	63.6	79.8
1969	53.9	64.8	75.6	83.6	88.7	92.9	58.2	67.9	81.7
1970	48.4	59.6	71.8	82.8	87.5	92.1	55.9	66.2	80.7
1971	43.9	55.6	69.2	85.4	89.0	92.8	56.5	68.0	83.9
1972	48.9	60.3	73.0	87.4	90.3	93.4	58.8	69.4	85.7
1973	46.2	57.9	71.4	89.5	92.2	94.6	56.8	66.1	82.7
1974	39.1	50.6	65.3	88.8	91.5	93.9	53.8	64.0	77.9

Table A.29 U.S. factory sales of trucks buses by gross vehicle weight.

Year	Less than 6,000 lbs	Less than 10,000 lbs	Less than 14,000 lbs	Less than 16,000 lbs	Less than 19,500 lbs	Less than 26,000 lbs	Less than 33,000 lbs
1962	27.8	36.5	36.9	38.0	43.8	47.7	49.1
1963	29.2	37.8	38.0	39.0	44.0	47.8	49.0
1964	30.5	38.8	39.0	39.8	44.5	48.0	48.9
1965	30.9	39.4	39.6	40.3	44.5	47.7	48.9
1966	30.3	39.1	39.3	39.9	43.6	47.3	48.6
1967	30.0	39.6	39.8	40.4	43.3	47.4	48.7
1968	30.7	41.1	41.2	41.7	43.8	47.7	48.8
1969	30.1	40.9	41.1	41.5	43.6	47.5	48.4
1970	28.9	41.2	41.4	41.7	43.5	47.3	48.5
1971	29.9	42.1	42.6	42.9	44.4	47.7	48.6
1972	29.8	42.1	43.0	43.2	43.8	47.6	48.5
1973	30.0	43.1	43.9	44.0	44.3	47.8	48.6
1974	29.1	43.0	43.1	43.2	43.4	47.7	48.4
1975	22.1	43.8	44.1	44.1	44.4	48.3	48.9
1976	21.4	45.2	45.5	45.5	45.7	48.6	49.0

Table A.30 Estimated number of tires per commercial vehicle.

Countries		Year 1975 - 2000
1	U.S.A.	8.0
2	Canada	8.0
3	Japan	6.0
4-5	Australia and New Zealand	8.0
6	West Germany	9.0
7	France	8.5
8	United Kingdom	8.0
9-14	Northern Europe I	8.5
15-18	Northern Europe II	8.0
19	Italy	8.0
20-25	Southern Europe	7.5
26-32	Eastern Europe	8.0
33-58	Rest of the world	6.0

Table A.31 Projections of demand for original equipment tires (in thousands) for commercial vehicles

	code	scenario	1985	1990	1995	2000
I. North America	C	G1	3802.	1397.	0.	0.
		G2	4700.	1803.	0.	0.
		G3	5575.	2172.	0.	0.
	R	G1	15449.	26543.	27294.	25516.
		G2	18802.	34258.	33944.	41237.
		G3	22298.	40313.	48461.	55311.
	T	G1	19316.	27940.	27294.	25516.
		G2	23502.	36061.	38644.	41237.
		G3	27873.	42434.	48461.	55311.
II. Asia, developed	C	G1	3576.	2123.	1200.	0.
		G2	4032.	2373.	1532.	0.
		G3	4400.	2563.	1619.	0.
	R	G1	11083.	18114.	22797.	28931.
		G2	12097.	21353.	29117.	39551.
		G3	13199.	23968.	34350.	49024.
	T	G1	14716.	20127.	23996.	28931.
		G2	16129.	23725.	30650.	39551.
		G3	17598.	26531.	36969.	49024.
III. Oceania,developed	C	G1	327.	128.	67.	0.
		G2	349.	152.	85.	0.
		G3	379.	171.	101.	0.
	R	G1	739.	1153.	1280.	1402.
		G2	813.	1365.	1623.	1942.
		G3	965.	1535.	1915.	2428.
	T	G1	1065.	1282.	1347.	1402.
		G2	1162.	1517.	1708.	1942.
		G3	[illegible]	1706.	2016.	2428.
IV. North-West Europe	C	G1	298.	0.	0.	0.
		G2	317.	0.	0.	0.
		G3	338.	0.	0.	0.
	R	G1	8109.	9256.	9940.	10643.
		G2	8726.	10603.	12032.	13726.
		G3	9353.	11671.	13922.	15516.
	T	G1	8406.	9256.	9940.	10643.
		G2	9044.	10603.	12032.	13726.
		G3	9691.	11671.	13922.	15516.

Table A.31 (cont. 1)

	code	scenario	1985	1990	1995	2000
V. South-West Europe	C	G1	342.	104.	0.	0.
		G2	345.	127.	0.	0.
		G3	260.	146.	0.	0.
	R	G1	2579.	3195.	3583.	3898.
		G2	2597.	3905.	4747.	5598.
		G3	2997.	4474.	5745.	7133.
	T	G1	2922.	3299.	3583.	3898.
		G2	2942.	4033.	4747.	5598.
		G3	3352.	4620.	5745.	7133.
VI. Eastern Europe	C	G1	2836.	1894.	1002.	369.
		G2	2932.	2050.	1090.	415.
		G3	2963.	2084.	1156.	456.
	R	G1	2804.	4426.	5675.	7007.
		G2	2813.	4606.	6175.	7879.
		G3	2963.	4563.	6615.	8670.
	T	G1	5649.	6319.	6678.	7376.
		G2	5745.	6656.	7264.	8294.
		G3	5927.	6647.	7771.	9126.
VII. Latin America + Caribbean	C	G1	1554.	1196.	707.	277.
		G2	1717.	1422.	696.	378.
		G3	1878.	1603.	1066.	466.
	R	G1	1554.	2791.	6010.	8257.
		G2	1717.	3319.	5277.	7173.
		G3	1878.	3741.	5985.	8893.
	T	G1	3108.	3987.	6717.	8533.
		G2	3433.	4741.	5973.	7561.
		G3	3756.	5344.	7043.	9359.
IX. South Asia	C	G1	384.	377.	363.	304.
		G2	439.	465.	490.	434.
		G3	494.	535.	600.	451.
	R	G1	256.	565.	912.	1216.
		G2	292.	698.	1165.	1735.
		G3	329.	806.	1401.	2305.
	T	G1	640.	942.	1275.	1520.
		G2	736.	1163.	1655.	2169.
		G3	823.	1341.	2002.	2756.

Table A.31 (cont. 2)

	code	scenario	1985	1990	1995	2000
X. South-East + East Asia	C	G1	575.	444.	263.	184.
		G2	647.	537.	374.	258.
		G3	721.	612.	449.	326.
	R	G1	863.	1776.	2593.	3488.
		G2	970.	2148.	3370.	4911.
		G3	1081.	2448.	4036.	6194.
	T	G1	1438.	2221.	2881.	3671.
		G2	1617.	2686.	3745.	5169.
		G3	1802.	3059.	4484.	6520.
XI. Middle East + North Africa	C	G1	245.	170.	86.	49.
		G2	274.	201.	112.	68.
		G3	296.	225.	132.	85.
	R	G1	368.	680.	779.	934.
		G2	412.	804.	1004.	1299.
		G3	444.	900.	1192.	1619.
	T	G1	613.	850.	865.	983.
		G2	685.	1004.	1116.	1367.
		G3	739.	1125.	1324.	1705.
XII. Other Africa	C	G1	1267.	1154.	1143.	918.
		G2	1527.	1549.	1612.	1409.
		G3	1798.	1854.	2015.	1954.
	R	G1	845.	1731.	2768.	3674.
		G2	1018.	2322.	3761.	5635.
		G3	1199.	2781.	4703.	7416.
	T	G1	2112.	2885.	3911.	4592.
		G2	2546.	3870.	5373.	7044.
		G3	2997.	4635.	6718.	9369.
World total (excl. Asian CPE countries)	C	G1	15285.	8877.	4877.	2161.
		G2	17226.	10628.	6201.	2961.
		G3	19226.	12016.	7338.	3741.
	R	G1	44307.	70226.	81515.	91965.
		G2	50416.	85440.	106916.	130685.
		G3	56636.	97497.	128417.	165416.
	T	G1	59592.	79103.	86393.	94065.
		G2	67642.	96068.	113117.	133647.
		G3	75862.	109513.	135755.	169158.

Notes: C = conventional tires
R = radial tires
T = total tires

Table A.32a Average driving distance per year per passenger car in use. (Thousands of kilometres)

	1960	1965	1970	1975
United States[a)]	15.11	15.02	15.97	15.41
United Kingdom[b)]	12.76	11.69	13.50	13.50
Norway[b)]	9.33	10.64	10.62	13.45
Spain[b)]	n.a.	11.85	10.37	n.a.
Japan[c)]	n.a.	15.47	13.65	9.8

Table A.32b Average driving distance per year per commercial vehicle in use. (Thousands of kilometres)

	1960	1965	1970	1975
United States[a)]	17.23	19.11	18.49	n.a.
United Kingdom[b)]	19.49	20.55	21.55	21.07
Norway[b)]	n.a.	10.96	10.16	11.95
Spain[b)]	n.a.	16.89	14.09	n.a.
Japan: small trucks[d)]	24.85	11.82	12.15	n.a.
trucks and buses[d)]	37.27	17.74	18.22	n.a.

Notes: a) Motor Vehicle Facts and Figures.

b) Derived from United Nations, Annual Bulletin of Transport Statistics for Europe, 1959-1975 by dividing total distance by vehicles in use.

c) Derived from International Road Federation, World Road Statistics, by dividing total distance by cars in use.

d) Japan Automobile Tire Manufacturers Association (1975).

Table A.33 Projected average driving distance per year per passenger car in use

	1980	1985	1990	1995	2000
United States	15.0	14.5	14.0	13.0	12.0
Canada	15.0	14.5	14.0	13.0	12.0
Japan	8.5	8.1	8.0	8.0	8.0
Oceania	16.0	15.0	14.0	13.0	12.0
Western Europe	12.0	10.0	9.0	8.0	8.0
Eastern Europe	16.0	16.0	16.0	16.0	16.0
Latin America	20.0	20.0	19.0	18.0	17.0
Rest of the world	20.0	20.0	20.0	19.0	18.0

Table A.34 Projected average driving distance per year per commercial vehicle in use

	1980	1985	1990	1995	2000
United States	18.0	17.5	17.0	16.5	16.0
Canada	18.0	17.5	17.0	16.5	16.0
Japan	15.0	14.5	14.0	13.5	13.0
Oceania	18.5	18.0	17.5	17.0	16.5
Western Europe	18.0	17.5	17.0	16.5	16.0
Eastern Europe	19.0	18.5	18.0	17.5	17.0
Latin America	20.0	20.0	20.0	20.0	20.0
Rest of the world	20.0	20.0	20.0	20.0	20.0

Table A.35 Projected percentage share of retreaded tires for replacement for passenger car tires, conventional and radial

Country/region		1980	1985	1990	1995	2000
North America	C	20	25	30	30	30
	R	10	15	20	25	30
Japan	C	15	20	25	30	30
	R	10	15	20	25	30
Oceania	C	10	15	20	25	25
	R	5	10	15	15	20
Western Europe	C	20	25	30	30	30
	R	10	15	20	25	30
Eastern Europe	C	10	15	15	20	25
	R	5	5	10	15	20
Latin America	C	5	10	10	15	20
	R	2	5	5	10	15
Rest of the world	C	5	5	10	10	15
	R	2	2	5	5	10

Notes: C = conventional tires
R = radial tires

Table A. 36 Projected percentage share of retreaded tires for replacement for commercial vehicle tires, conventional and radial.

Country/region	Year	1980	1985	1990	1995	2000
North America	C	40	45	45	50	50
	R	30	35	40	45	50
Japan	C	45	45	50	50	50
	R	30	35	40	45	50
Oceania	C	40	45	45	45	50
	R	25	30	35	40	45
Western Europe	C	50	50	50	50	50
	R	40	45	50	50	50
Eastern Europe	C	40	45	45	45	50
	R	25	30	35	40	45
Latin America	C	20	25	25	30	30
	R	5	10	15	20	20
Rest of the world	C	10	15	20	20	25
	R	0	5	10	15	15

Note: C = conventional tires.
R = radial tires.

Table A.37 Projections of demand for replacement tires (in thousands) for passenger cars

		code	scenario	1985	1990	1995	2000
I.	North America	C	a	28750.	6624.	0.	0.
			b	29029.	6944.	0.	0.
			c	29576.	7129.	0.	0.
			d	29729.	7381.	0.	0.
			e	29886.	7513.	0.	0.
		R	a	115000.	125851.	127379.	122453.
			b	116116.	131936.	134575.	127793.
			c	118303.	135452.	141991.	136844.
			d	118915.	140247.	145944.	138074.
			e	119545.	142753.	153336.	147499.
		T	a	143750.	132474.	127379.	122453.
			b	145145.	138880.	134575.	127793.
			c	147878.	142581.	141991.	136844.
			d	148643.	147628.	145944.	138074.
			e	149432.	150266.	153336.	147499.
II.	Asia, developed	C	a	810.	0.	0.	0.
			b	815.	0.	0.	0.
			c	793.	0.	0.	0.
			d	797.	0.	0.	0.
			e	799.	0.	0.	0.
		R	a	15382.	17273.	17533.	15630.
			b	15478.	18158.	17857.	15676.
			c	15067.	17970.	19288.	16969.
			d	15135.	18821.	19517.	17014.
			e	15190.	19441.	21154.	18317.
		T	a	16192.	17273.	17533.	15630.
			b	16292.	18158.	17857.	15676.
			c	15860.	17970.	19288.	16969.
			d	15931.	18821.	19517.	17014.
			e	15990.	19441.	21154.	18317.
III.	Oceania, developed	C	a	1715.	435.	0.	0.
			b	1728.	458.	0.	0.
			c	1725.	462.	0.	0.
			d	1735.	484.	0.	0.
			e	1737.	490.	0.	0.
		R	a	6860.	8259.	8640.	8564.
			b	6913.	8710.	9362.	9047.
			c	6898.	8769.	9770.	9759.
			d	6941.	9191.	10326.	9950.
			e	6949.	9317.	10827.	10662.
		T	a	8575.	8693.	8640.	8564.
			b	8641.	9168.	9362.	9047.
			c	8623.	9230.	9770.	9759.
			d	8677.	9675.	10326.	9950.
			e	8686.	9807.	10827.	10662.

Table A.37 (cont.1)

		code	scenario	1985	1990	1995	2000
IV.	North-West Europe	C	a	2183.	0.	0.	0.
			b	2193.	0.	0.	0.
			c	2217.	0.	0.	0.
			d	2225.	0.	0.	0.
			e	2246.	0.	0.	0.
		R	a	53278.	47382.	41151.	33673.
			b	53472.	48419.	42189.	34782.
			c	53878.	49957.	44036.	36537.
			d	54052.	50988.	44852.	37504.
			e	54459.	52702.	46866.	39386.
		T	a	55462.	47382.	41151.	33673.
			b	55665.	48419.	42189.	34782.
			c	56094.	49957.	44036.	36537.
			d	56277.	50988.	44852.	37504.
			e	56705.	52702.	46866.	39386.
V.	South-West Europe	C	a	576.	0.	0.	0.
			b	585.	0.	0.	0.
			c	584.	0.	0.	0.
			d	590.	0.	0.	0.
			e	590.	0.	0.	0.
		R	a	26555.	25706.	24843.	25037.
			b	26803.	27090.	27015.	27589.
			c	26839.	27413.	27948.	28723.
			d	27042.	28696.	29716.	30937.
			e	27081.	29004.	30596.	31924.
		T	a	27131.	25706.	24843.	25037.
			b	27388.	27090.	27015.	27589.
			c	27423.	27413.	27948.	28723.
			d	27632.	28696.	29716.	30937.
			e	27672.	29004.	30596.	31924.
VI.	Eastern Europe	C	a	8659.	4742.	2806.	1569.
			b	8950.	5268.	3362.	2024.
			c	8950.	5268.	3362.	2024.
			d	9189.	5706.	3819.	2412.
			e	9189.	5706.	3819.	2412.
		R	a	12989.	18966.	25258.	29817.
			b	13424.	21074.	30258.	38459.
			c	13424.	21074.	30258.	38459.
			d	13783.	22826.	34373.	45825.
			e	13783.	22826.	34373.	45825.
		T	a	21648.	23708.	28064.	31386.
			b	22374.	26342.	33620.	40483.
			c	22374.	26342.	33620.	40483.
			d	22972.	28532.	38192.	48236.
			e	22972.	28532.	38192.	48236.

Table A.37 (cont. 2).

	code	scenario	1985	1990	1995	2000
VII. Latin America + Caribbean	C	a	15406.	8785.	5475.	3273.
		b	16135.	10215.	7159.	4842.
		c	16135.	10215.	7159.	4842.
		d	16807.	11489.	8744.	6463.
		e	16807.	11489.	8744.	6463.
	R	a	23108.	35138.	49276.	62194.
		b	24203.	40861.	64432.	92005.
		c	24203.	40861.	64432.	92005.
		d	25210.	45957.	78697.	122793.
		e	25210.	45957.	78697.	122793.
	T	a	38514.	43923.	54751.	65467.
		b	40339.	51076.	71591.	96847.
		c	40339.	51076.	71591.	96847.
		d	42017.	57446.	87441.	129255.
		e	42017.	57446.	87441.	129255.
IX. South Asia	C	a	2351.	1991.	1820.	1422.
		b	2422.	2181.	2123.	1765.
		c	2422.	2181.	2123.	1765.
		d	2487.	2337.	2374.	2058.
		e	2487.	2337.	2374.	2058.
	R	a	1568.	2987.	4246.	5688.
		b	1615.	3272.	4955.	7061.
		c	1615.	3272.	4955.	7061.
		d	1658.	3506.	5539.	8230.
		e	1658.	3506.	5539.	8230.
	T	a	3919.	4978.	6066.	7109.
		b	4037.	5453.	7078.	8826.
		c	4037.	5453.	7078.	8826.
		d	4145.	5843.	7912.	10288.
		e	4145.	5843.	7912.	10288.
X. South-East + East Asia	C	a	2368.	1132.	794.	0.
		b	2421.	1221.	911.	0.
		c	2421.	1221.	911.	0.
		d	2469.	1295.	1008.	0.
		e	2469.	1295.	1008.	0.
	R	a	5524.	10190.	15085.	23042.
		b	5650.	10993.	17305.	28189.
		c	5650.	10993.	17305.	28189.
		d	5761.	11657.	19151.	32651.
		e	5761.	11657.	19151.	32651.
	T	a	7892.	11323.	15879.	23042.
		b	8071.	12214.	18216.	28189.
		c	8071.	12214.	18216.	28189.
		d	8231.	12952.	20159.	32651.
		e	8231.	12952.	20159.	32651.

Table A.37 (cont. 3).

	code	scenario	1985	1990	1995	2000
XI. Middle East + North Africa	C	a	1982.	741.	408.	0.
		b	2071.	853.	520.	0.
		c	2071.	853.	520.	0.
		d	2134.	938.	612.	0.
		e	2134.	938.	612.	0.
	R	a	4625.	6665.	7754.	8905.
		b	4832.	7678.	9878.	12619.
		c	4832.	7678.	9878.	12619.
		d	4979.	8438.	11619.	15938.
		e	4979.	8438.	11619.	15938.
	T	a	6607.	7406.	8162.	8905.
		b	6903.	8531.	10398.	12619.
		c	6903.	8531.	10398.	12619.
		d	7113.	9376.	12231.	15938.
		e	7113.	9376.	12231.	15938.
XII. Other Africa	C	a	8982.	7095.	6147.	4624.
		b	9082.	7356.	6520.	5005.
		c	9082.	7356.	6520.	5005.
		d	9177.	7563.	6819.	5325.
		e	9177.	7563.	6819.	5325.
	R	a	5988.	10642.	14343.	18496.
		b	6055.	11035.	15213.	20019.
		c	6055.	11035.	15213.	20019.
		d	6118.	11344.	15912.	21300.
		e	6118.	11344.	15912.	21300.
	T	a	14969.	17737.	20490.	23120.
		b	15136.	18391.	21733.	25024.
		c	15136.	18391.	21733.	25024.
		d	15295.	18907.	22731.	26625.
		e	15295.	18907.	22731.	26625.
World total (exl. Asian CPE countries)	C	a	73782.	31543.	17450.	10889.
		b	75431.	34498.	20595.	13636.
		c	75975.	34686.	20595.	13636.
		d	77339.	37194.	23376.	16257.
		e	77522.	37332.	23376.	16257.
	R	a	270876.	309059.	335509.	353498.
		b	274561.	329224.	373038.	413239.
		c	276764.	334473.	385073.	427185.
		d	279594.	351671.	415645.	480215.
		e	280734.	356944.	428069.	494525.
	T	a	344658.	340602.	352960.	364387.
		b	349993.	363722.	393633.	426875.
		c	352739.	369159.	405669.	440821.
		d	356933.	388865.	439021.	496472.
		e	358256.	394276.	451445.	510792.

Notes: C = convential tires
R = radial tires
T = total tires

Table A.38 Projections of demand for retreaded tires (in thousands) for passenger cars

	code	scenario	1985	1990	1995	2000
I. North America	C	a	7066.	1956.	0.	0.
		b	7134.	2050.	0.	0.
		c	7271.	2106.	0.	0.
		d	7308.	2180.	0.	0.
		e	7347.	2218.	0.	0.
	R	a	16762.	24582.	31209.	36111.
		b	16925.	25765.	32961.	37686.
		c	17253.	26459.	34782.	40355.
		d	17341.	27387.	35741.	40718.
		e	17434.	27874.	37546.	43493.
	T	a	23828.	26538.	31209.	36111.
		b	24060.	27815.	32961.	37686.
		c	24524.	28565.	34782.	40355.
		d	24650.	29567.	35741.	40718.
		e	24781.	30093.	37546.	43493.
II. Asia, developed	C	a	259.	0.	0.	0.
		b	261.	0.	0.	0.
		c	254.	0.	0.	0.
		d	255.	0.	0.	0.
		e	256.	0.	0.	0.
	R	a	4922.	6391.	7364.	7346.
		b	4953.	6718.	7500.	7368.
		c	4821.	6649.	8101.	7975.
		d	4843.	6964.	8197.	7997.
		e	4861.	7193.	8885.	8609.
	T	a	5181.	6391.	7364.	7346.
		b	5213.	6718.	7500.	7368.
		c	5075.	6649.	8101.	7975.
		d	5098.	6964.	8197.	7997.
		e	5117.	7193.	8885.	8609.
III. Oceania,developed	C	a	257.	87.	0.	0.
		b	259.	92.	0.	0.
		c	259.	92.	0.	0.
		d	260.	97.	0.	0.
		e	261.	98.	0.	0.
	R	a	686.	1239.	1728.	1713.
		b	691.	1306.	1872.	1809.
		c	690.	1315.	1954.	1952.
		d	694.	1379.	2065.	1990.
		e	695.	1398.	2165.	2132.
	T	a	943.	1326.	1728.	1713.
		b	951.	1398.	1872.	1809.
		c	948.	1408.	1954.	1952.
		d	954.	1475.	2065.	1990.
		e	956.	1496.	2165.	2132.

		code	scenario	1985	1990	1995	2000
IV.	North-West Europe	C	a	546.	0.	0.	0.
			b	548.	0.	0.	0.
			c	554.	0.	0.	0.
			d	556.	0.	0.	0.
			e	562.	0.	0.	0.
		R	a	7992.	9476.	10288.	10102.
			b	8021.	9684.	10547.	10435.
			c	8082.	9991.	11009.	10951.
			d	8108.	10198.	11213.	11251.
			e	8169.	10540.	11717.	11816.
		T	a	8538.	9476.	10288.	10102.
			b	8569.	9684.	10547.	10435.
			c	8636.	9991.	11009.	10951.
			d	8664.	10198.	11213.	11251.
			e	8730.	10540.	11717.	11816.
V.	South-West Europe	C	a	144.	0.	0.	0.
			b	146.	0.	0.	0.
			c	146.	0.	0.	0.
			d	148.	0.	0.	0.
			e	148.	0.	0.	0.
		R	a	3983.	5141.	6211.	7511.
			b	4021.	5418.	6754.	8277.
			c	4026.	5483.	6987.	8617.
			d	4056.	5739.	7429.	9281.
			e	4062.	5801.	7649.	9577.
		T	a	4127.	5141.	6211.	7511.
			b	4167.	5418.	6754.	8277.
			c	4172.	5483.	6987.	8617.
			d	4204.	5739.	7429.	9281.
			e	4210.	5801.	7649.	9577.
VI.	Eastern Europe	C	a	1299.	948.	702.	392.
			b	1342.	1054.	841.	506.
			c	1342.	1054.	841.	506.
			d	1378.	1141.	955.	603.
			e	1378.	1141.	955.	603.
		R	a	1299.	2845.	5052.	5963.
			b	1342.	3161.	6052.	7692.
			c	1342.	3161.	6052.	7692.
			d	1378.	3424.	6875.	9165.
			e	1378.	3424.	6875.	9165.
		T	a	2598.	3793.	5753.	6356.
			b	2685.	4215.	6892.	8198.
			c	2685.	4215.	6892.	8198.
			d	2757.	4565.	7829.	9768.
			e	2757.	4565.	7829.	9768.

Table A.38 (cont.2)

	code	scenario	1985	1990	1995	2000
VII. Latin America + Caribbean	C	a	1541.	878.	821.	655.
		b	1614.	1022.	1074.	968.
		c	1614.	1022.	1074.	968.
		d	1681.	1149.	1312.	1293.
		e	1681.	1149.	1312.	1293.
	R	a	1155.	1757.	4928.	9329.
		b	1210.	2043.	6443.	13801.
		c	1210.	2043.	6443.	13801.
		d	1261.	2298.	7870.	18419.
		e	1261.	2298.	7870.	18419.
	T	a	2696.	2635.	5749.	9984.
		b	2824.	3065.	7517.	14769.
		c	2824.	3065.	7517.	14769.
		d	2941.	3447.	9181.	19711.
		e	2941.	3447.	9181.	19711.
IX. South Asia	C	a	118.	199.	182.	213.
		b	121.	218.	212.	265.
		c	121.	218.	212.	265.
		d	124.	234.	237.	309.
		e	124.	234.	237.	309.
	R	a	31.	149.	340.	569.
		b	32.	164.	396.	706.
		c	32.	164.	396.	706.
		d	33.	175.	443.	823.
		e	33.	175.	443.	823.
	T	a	149.	348.	522.	782.
		b	153.	382.	609.	971.
		c	153.	382.	609.	971.
		d	158.	409.	680.	1132.
		e	158.	409.	680.	1132.
X. South-East + East Asia	C	a	118.	113.	79.	0.
		b	121.	122.	91.	0.
		c	121.	122.	91.	0.
		d	123.	130.	101.	0.
		e	123.	130.	101.	0.
	R	a	110.	510.	1207.	2304.
		b	113.	550.	1384.	2819.
		c	113.	550.	1384.	2819.
		d	115.	583.	1532.	3265.
		e	115.	583.	1532.	3265.
	T	a	229.	623.	1286.	2304.
		b	234.	672.	1476.	2819.
		c	234.	672.	1476.	2819.
		d	239.	712.	1633.	3265.
		e	239.	712.	1633.	3265.

Table A.38 (cont.3)

	code	scenario	1985	1990	1995	2000
XI. Middle East + North Africa	C	a	99.	74.	41.	0.
		b	104.	85.	52.	0.
		c	104.	85.	52.	0.
		d	107.	94.	61.	0.
		e	107.	94.	61.	0.
	R	a	92.	333.	620.	891.
		b	97.	384.	790.	1262.
		c	97.	384.	790.	1262.
		d	100.	422.	930.	1594.
		e	100.	422.	930.	1594.
	T	a	192.	407.	661.	891.
		b	200.	469.	842.	1262.
		c	200.	469.	842.	1262.
		d	206.	516.	991.	1594.
		e	206.	516.	991.	1594.
XII. Other Africa	C	a	449.	709.	615.	694.
		b	454.	736.	652.	751.
		c	454.	736.	652.	751.
		d	459.	756.	682.	799.
		e	459.	756.	682.	799.
	R	a	120.	532.	1147.	1850.
		b	121.	552.	1217.	2002.
		c	121.	552.	1217.	2002.
		d	122.	567.	1273.	2130.
		e	122.	567.	1273.	2130.
	T	a	569.	1242.	1762.	2543.
		b	575.	1287.	1869.	2753.
		c	575.	1287.	1869.	2753.
		d	581.	1323.	1955.	2929.
		e	581.	1323.	1955.	2929.
World total (excl. Asian CPE countries)	C	a	11895.	4966.	2440.	1954.
		b	12104.	5379.	2922.	2490.
		c	12239.	5434.	2922.	2490.
		d	12400.	5780.	3348.	3003.
		e	12445.	5820.	3348.	3003.
	R	a	37154.	52955.	70093.	83688.
		b	37526.	55744.	75917.	93856.
		c	37787.	56751.	79116.	98141.
		d	38052.	59135.	83567.	106632.
		e	38230.	60275.	86884.	111024.
	T	a	49049.	57921.	72533.	85642.
		b	49631.	61122.	78839.	96346.
		c	50027.	62185.	82037.	100631.
		d	50451.	64915.	86915.	109635.
		e	50675.	66095.	90231.	114026.

Notes: C = conventional tires
R = radial tires
T = total tires

Table A.39 Projections of demand for new tires (in thousands) for passenger cars

	code	scenario	1985	1990	1995	2000
I. North America	C	a	27348.	8053.	0.	0.
		b	28137.	8470.	0.	0.
		c	28663.	8903.	0.	0.
		d	29253.	9132.	0.	0.
		e	29503.	9528.	0.	0.
	R	a	149214.	165588.	161638.	154308.
		b	155369.	174127.	169623.	161319.
		c	158272.	182709.	180469.	173556.
		d	163066.	187536.	183441.	175270.
		e	164788.	195299.	194661.	187798.
	T	a	176562.	173641.	161638.	154308.
		b	183505.	182597.	169623.	161319.
		c	186935.	191612.	180469.	173556.
		d	192319.	196668.	183441.	175270.
		e	194291.	204826.	194661.	187798.
II. Asia,developed	C	a	3297.	1065.	0.	0.
		b	3536.	1068.	0.	0.
		c	3478.	1205.	0.	0.
		d	3716.	1192.	0.	0.
		e	3852.	1328.	0.	0.
	R	a	26025.	31120.	31431.	29437.
		b	27422.	31727.	31846.	29348.
		c	26899.	34224.	34684.	32400.
		d	28281.	34502.	35147.	32235.
		e	29074.	37474.	38255.	35198.
	T	a	29322.	32186.	31431.	29437.
		b	30958.	32795.	31846.	29348.
		c	30377.	35430.	34684.	32400.
		d	31997.	35694.	35147.	32235.
		e	32925.	38802.	38255.	35198.
III. Oceania, developed	C	a	2206.	560.	0.	0.
		b	2288.	604.	0.	0.
		c	2291.	624.	0.	0.
		d	2371.	659.	0.	0.
		e	2387.	685.	0.	0.
	R	a	9166.	11059.	11499.	11462.
		b	9499.	11909.	12166.	12027.
		c	9510.	12298.	13002.	13004.
		d	9832.	12976.	13315.	13245.
		e	9895.	13486.	14166.	14172.
	T	a	11372.	11620.	11499.	11462.
		b	11788.	12513.	12166.	12027.
		c	11801.	12923.	13002.	13004.
		d	12204.	13635.	13315.	13245.
		e	12282.	14171.	14166.	14172.

Table A.39 (cont.1)

	code	scenario	1985	1990	1995	2000
IV. North-West Europe	C	a	2907.	0.	0.	0.
		b	2962.	0.	0.	0.
		c	3081.	0.	0.	0.
		d	3142.	0.	0.	0.
		e	3271.	0.	0.	0.
	R	a	85901.	81220.	73848.	66315.
		b	87449.	83067.	76331.	68687.
		c	89692.	86318.	80294.	72729.
		d	91343.	87778.	82495.	74661.
		e	93880.	91230.	86813.	78945.
	T	a	88809.	81220.	73848.	66315.
		b	90411.	83067.	76331.	68687.
		c	92773.	86318.	80294.	72729.
		d	94485.	87778.	82495.	74661.
		e	97150.	91230.	86813.	78945.
V. South-West Europe	C	a	725.	0.	0.	0.
		b	761.	0.	0.	0.
		c	759.	0.	0.	0.
		d	794.	0.	0.	0.
		e	794.	0.	0.	0.
	R	a	37010.	37405.	36422.	35800.
		b	38624.	40234.	39973.	40842.
		c	38994.	41598.	41474.	42379.
		d	40635.	43779.	44674.	47649.
		e	40982.	45060.	45949.	49042.
	T	a	37736.	37405.	36422.	35800.
		b	39384.	40234.	39973.	40842.
		c	39753.	41598.	41474.	42379.
		d	41428.	43779.	44674.	47649.
		e	41776.	45060.	45949.	49042.
VI. Eastern Europe	C	a	10574.	5860.	3294.	1883.
		b	11221.	6736.	4101.	2523.
		c	11221.	6736.	4101.	2523.
		d	11840.	7452.	4782.	3084.
		e	11840.	7452.	4782.	3084.
	R	a	16510.	24386.	30913.	37263.
		b	17503.	27998.	38425.	49858.
		c	17503.	27998.	38425.	49858.
		d	18449.	30951.	44755.	60889.
		e	18449.	30951.	44755.	60889.
	T	a	27084.	30246.	34207.	39146.
		b	28724.	34734.	42526.	52381.
		c	28724.	34734.	42526.	52381.
		d	30289.	38403.	49536.	63973.
		e	30289.	38403.	49536.	63973.

Table A.39 (cont.2)

	code	scenario	1985	1990	1995	2000
VII. Latin America + Caribbean	C	a	17803.	10868.	6652.	3953.
		b	19282.	13287.	9248.	6297.
		c	19282.	13287.	9248.	6297.
		d	20784.	15484.	11817.	8870.
		e	20784.	15484.	11817.	8870.
	R	a	27860.	45227.	62335.	78219.
		b	30132.	55193.	86451.	124244.
		c	30132.	55193.	86451.	124244.
		d	32437.	64234.	110290.	174677.
		e	32437.	64234.	110290.	174677.
	T	a	45663.	56095.	68987.	82172.
		b	49414.	68480.	95699.	130541.
		c	49414.	68480.	95699.	130541.
		d	53221.	79718.	122107.	183547.
		e	53221.	79718.	122107.	183547.
IX. South Asia	C	a	2941.	2408.	2254.	1713.
		b	3084.	2702.	2690.	2185.
		c	3084.	2702.	2690.	2185.
		d	3223.	2941.	3055.	2597.
		e	3223.	2941.	3055.	2597.
	R	a	2008.	3761.	5345.	7137.
		b	2104.	4216.	6376.	9093.
		c	2104.	4216.	6376.	9093.
		d	2199.	4587.	7240.	10798.
		e	2199.	4587.	7240.	10798.
	T	a	4949.	6169.	7599.	8850.
		b	5188.	6917.	9066.	11278.
		c	5188.	6917.	9066.	11278.
		d	5422.	7528.	10295.	13395.
		e	5422.	7528.	10295.	13395.
X. South-East + East Asia	C	a	3072.	1475.	1081.	0.
		b	3196.	1634.	1278.	0.
		c	3196.	1634.	1278.	0.
		d	3316.	1765.	1445.	0.
		e	3316.	1765.	1445.	0.
	R	a	7334.	13786.	20840.	32251.
		b	7627.	15257.	24622.	40801.
		c	7627.	15257.	24622.	40801.
		d	7910.	16466.	27834.	48425.
		e	7910.	16466.	27834.	48425.
	T	a	10406.	15261.	21921.	32251.
		b	10823.	16891.	25900.	40801.
		c	10823.	16891.	25900.	40801.
		d	11225.	18230.	29279.	48425.
		e	11225.	18230.	29279.	48425.

Table A.39 (cont.3)

	code	scenario	1985	1990	1995	2000
XI. Middle East + North Africa	C	a	2469.	916.	507.	0.
		b	2649.	1094.	677.	0.
		c	2649.	1094.	677.	0.
		d	2784.	1233.	821.	0.
		e	2784.	1233.	821.	0.
	R	a	5900.	8579.	9798.	11391.
		b	6326.	10226.	13054.	16852.
		c	6326.	10226.	13054.	16852.
		d	6646.	11515.	15832.	21935.
		e	6646.	11515.	15832.	21935.
	T	a	8369.	9496.	10305.	11391.
		b	8975.	11320.	13731.	16852.
		c	8975.	11320.	13731.	16852.
		d	9430.	12747.	16653.	21935.
		e	9430.	12747.	16653.	21935.
XII. Other Africa	C	a	10685.	8248.	7356.	5443.
		b	10881.	8635.	7871.	5952.
		c	10881.	8635.	7871.	5952.
		d	11077.	8938.	8296.	6392.
		e	11077.	8938.	8296.	6392.
	R	a	7303.	12904.	17452.	22696.
		b	7436.	13504.	18671.	24809.
		c	7436.	13504.	18671.	24809.
		d	7568.	13974.	19674.	26631.
		e	7568.	13974.	19674.	26631.
	T	a	17988.	21152.	24808.	28138.
		b	18317.	22140.	26542.	30761.
		c	18317.	22140.	26542.	30761.
		d	18645.	22911.	27970.	33023.
		e	18645.	22911.	27970.	33023.
World total (excl. Asian CPE countries)	C	a	84028.	39452.	21146.	12992.
		b	87996.	44230.	25865.	16957.
		c	88585.	44821.	25865.	16957.
		d	92300.	48795.	30216.	20943.
		e	92830.	49353.	30216.	20943.
	R	a	374232.	435036.	461519.	486278.
		b	389492.	467458.	517539.	577881.
		c	394495.	483543.	537523.	599725.
		d	408364.	508298.	584696.	686417.
		e	413827.	524274.	605459.	708511.
	T	a	458260.	474489.	482664.	499270.
		b	477488.	511687.	543404.	594838.
		c	483080.	528363.	563388.	616681.
		d	500665.	557093.	614912.	707359.
		e	506657.	573627.	635685.	729454.

Notes: C = conventional tires
R = radial tires
T = total tires

Table A.40 Projections of demand for replacement tires (in thousands) for commercial vehicles

	code	scenario	1985	1990	1995	2000
I. North America	C	G1	10137.	2385.	0.	0.
		G2	10752.	2761.	0.	0.
		G3	11001.	3028.	0.	0.
	R	G1	40546.	45316.	48840.	51164.
		G2	43008.	52454.	61969.	70059.
		G3	44003.	57529.	71964.	85308.
	T	G1	50685.	47703.	48840.	51164.
		G2	53761.	55214.	61969.	70059.
		G3	55003.	60557.	71964.	85308.
II. Asia, developed	C	G1	3622.	974.	0.	0.
		G2	3742.	1084.	0.	0.
		G3	3833.	1175.	0.	0.
	R	G1	14489.	18497.	22597.	25649.
		G2	14967.	20593.	27081.	33060.
		G3	15332.	22331.	30736.	39350.
	T	G1	18112.	19470.	22597.	25649.
		G2	18709.	21677.	27081.	33060.
		G3	19165.	23506.	30736.	39350.
III. Oceania, developed	C	G1	856.	257.	126.	0.
		G2	863.	270.	142.	0.
		G3	869.	282.	155.	0.
	R	G1	1997.	2310.	2400.	2595.
		G2	2014.	2434.	2703.	3131.
		G3	2027.	2542.	2954.	3580.
	T	G1	2853.	2567.	2526.	2595.
		G2	2877.	2705.	2846.	3131.
		G3	2896.	2824.	3109.	3580.
IV. North-West Europe	C	G1	391.	0.	0.	0.
		G2	399.	0.	0.	0.
		G3	403.	0.	0.	0.
	R	G1	10707.	10991.	11570.	11965.
		G2	10876.	11771.	13282.	14685.
		G3	10975.	12431.	14677.	16955.
	T	G1	11098.	10991.	11570.	11965.
		G2	11275.	11771.	13282.	14685.
		G3	11378.	12431.	14677.	16955.

Table A.40 (cont.1)

		code	scenario	1985	1990	1995	2000
V.	South-West Europe	C	G1	858.	242.	0.	0.
			G2	879.	265.	0.	0.
			G3	894.	284.	0.	0.
		R	G1	6077.	6424.	6885.	7234.
			G2	6154.	7000.	8090.	9137.
			G3	6254.	7485.	9084.	10749.
		T	G1	6936.	6666.	6885.	7234.
			G2	7033.	7265.	8090.	9137.
			G3	7149.	7769.	9084.	10749.
VI.	Eastern Europe	C	G1	6276.	3514.	1732.	556.
			G2	6319.	3604.	1819.	601.
			G3	6355.	3678.	1891.	638.
		R	G1	6276.	8199.	9812.	10563.
			G2	6319.	8408.	10309.	11411.
			G3	6355.	8582.	10718.	12129.
		T	G1	12553.	11713.	11544.	11119.
			G2	12639.	12012.	12129.	12012.
			G3	12709.	12260.	12609.	12768.
VII.	Latin America+ Caribbean	C	G1	6218.	3757.	2006.	715.
			G2	6297.	3969.	2243.	849.
			G3	6359.	4148.	2439.	962.
		R	G1	6218.	8766.	11366.	13587.
			G2	6297.	9261.	12712.	16134.
			G3	6359.	9678.	13818.	18280.
		T	G1	12436.	12523.	13372.	14303.
			G2	12593.	13230.	14955.	16984.
			G3	12718.	13825.	16257.	19242.
IX.	South Asia	C	G1	1361.	1024.	887.	692.
			G2	1397.	1118.	1039.	866.
			G3	1428.	1196.	1163.	1015.
		R	G1	907.	1536.	2069.	2767.
			G2	932.	1677.	2423.	3465.
			G3	952.	1795.	2715.	4058.
		T	G1	2269.	2560.	2956.	3458.
			G2	2329.	2796.	3462.	4332.
			G3	2379.	2991.	3878.	5073.

Table A.40 (cont.2)

	code	scenario	1985	1990	1995	2000
X. South-East + East Asia	C	G1	1625.	942.	558.	359.
		G2	1666.	1027.	650.	448.
		G3	1698.	1097.	726.	523.
	R	G1	2437.	3769.	5021.	6823.
		G2	2498.	4107.	5852.	8505.
		G3	2547.	4386.	6534.	9928.
	T	G1	4062.	4711.	5579.	7182.
		G2	4164.	5134.	6502.	8953.
		G3	4245.	5483.	7260.	10451.
XI. Middle East + North Africa	C	G1	782.	390.	202.	113.
		G2	801.	423.	234.	139.
		G3	812.	447.	258.	160.
	R	G1	1174.	1559.	1821.	2139.
		G2	1201.	1693.	2106.	2640.
		G3	1219.	1788.	2323.	3045.
	T	G1	1956.	1949.	2024.	2251.
		G2	2002.	2116.	2340.	2779.
		G3	2031.	2235.	2581.	3205.
XII. Other Africa	C	G1	3872.	2999.	2660.	2066.
		G2	4063.	3465.	3345.	2793.
		G3	4220.	3839.	3898.	3404.
	R	G1	2581.	4499.	6206.	8263.
		G2	2708.	5197.	7805.	11173.
		G3	2813.	5758.	9095.	13617.
	T	G1	6453.	7498.	8866.	10329.
		G2	6771.	8662.	11150.	13967.
		G3	7034.	9597.	12993.	17021.
World total (excl. Asian CPE countries)	C	G1	35999.	15483.	8170.	4500.
		G2	37177.	17986.	9473.	5696.
		G3	37872.	19174.	10531.	6702.
	R	G1	93363.	111868.	128589.	142748.
		G2	96975.	124597.	154332.	183400.
		G3	98835.	134305.	174617.	216999.
	T	G1	129362.	128361.	136759.	147249.
		G2	134152.	142582.	163805.	189096.
		G3	136707.	153480.	185148.	223701.

Notes: C = convential tires
R = radial tires
T = total tires

Table A.41 Projections of demand for retreaded tires (in thousands) for commercial vehicles

	code	scenario	1985	1990	1995	2000
I. North America	C	G1	4562.	1073.	0.	0.
		G2	4838.	1242.	0.	0.
		G3	4950.	1363.	0.	0.
	R	G1	14192.	18127.	21978.	25582.
		G2	15053.	20981.	27885.	35030.
		G3	15401.	23012.	32384.	42654.
	T	G1	18754.	19201.	21978.	25582.
		G2	19891.	22224.	27885.	35030.
		G3	20351.	24374.	32384.	42654.
II. Asia, developed	C	G1	1630.	487.	0.	0.
		G2	1684.	542.	0.	0.
		G3	1725.	588.	0.	0.
	R	G1	5071.	7399.	10169.	12824.
		G2	5238.	8237.	12186.	16530.
		G3	5366.	8932.	13831.	19675.
	T	G1	6701.	7885.	10169.	12624.
		G2	6922.	8779.	12186.	16530.
		G3	7091.	9520.	13831.	19675.
III. Oceania, developed	C	G1	385.	115.	57.	0.
		G2	388.	122.	64.	0.
		G3	391.	127.	70.	0.
	R	G1	599.	808.	960.	1168.
		G2	604.	852.	1081.	1409.
		G3	608.	890.	1181.	1611.
	T	G1	984.	924.	1017.	1168.
		G2	992.	974.	1145.	1409.
		G3	999.	1017.	1251.	1611.
IV. North-West Europe	C	G1	196.	0.	0.	0.
		G2	200.	0.	0.	0.
		G3	202.	0.	0.	0.
	R	G1	4283.	4946.	5785.	5983.
		G2	4350.	5297.	6641.	7342.
		G3	4390.	5594.	7339.	8478.
	T	G1	4478.	4946.	5785.	5983.
		G2	4550.	5297.	6641.	7342.
		G3	4592.	5594.	7339.	8478.

Table A.41 (cont.1)

	code	scenario	1985	1990	1995	2000
V. South-West Europe	C	G1	429.	121.	0.	0.
		G2	439.	132.	0.	0.
		G3	447.	142.	0.	0.
	R	G1	2411.	2891.	3443.	3617.
		G2	2462.	3150.	4045.	4568.
		G3	2502.	3368.	4542.	5374.
	T	G1	2840.	3012.	3443.	3617.
		G2	2901.	3283.	4045.	4568.
		G3	2949.	3510.	4542.	5374.
VI. Eastern Europe	C	G1	2824.	1581.	779.	278.
		G2	2844.	1622.	819.	300.
		G3	2860.	1655.	851.	319.
	R	G1	1883.	2870.	3925.	4753.
		G2	1896.	2943.	4124.	5135.
		G3	1906.	3004.	4287.	5458.
	T	G1	4707.	4451.	4704.	5031.
		G2	4740.	4564.	4942.	5435.
		G3	4766.	4659.	5138.	5777.
VII. Latin America + Caribbean	C	G1	1554.	939.	602.	215.
		G2	1574.	992.	673.	255.
		G3	1590.	1037.	732.	289.
	R	G1	311.	877.	1705.	2717.
		G2	315.	926.	1907.	3227.
		G3	318.	968.	2073.	3656.
	T	G1	1865.	1816.	2307.	2932.
		G2	1889.	1918.	2580.	3482.
		G3	1908.	2005.	2804.	3945.
IX. South Asia	C	G1	204.	205.	177.	173.
		G2	210.	224.	208.	217.
		G3	214.	239.	233.	254.
	R	G1	45.	154.	310.	415.
		G2	47.	168.	363.	520.
		G3	48.	179.	407.	609.
	T	G1	250.	358.	488.	588.
		G2	256.	391.	571.	736.
		G3	262.	419.	640.	862.

Table A.41 (cont.2)

	code	scenario	1985	1990	1995	2000
X. South-East + East Asia	C	G1	244.	188.	112.	90.
		G2	250.	205.	130.	112.
		G3	258.	219.	145.	131.
	R	G1	122.	377.	753.	1023.
		G2	125.	411.	878.	1276.
		G3	127.	439.	980.	1489.
	T	G1	366.	565.	865.	1113.
		G2	375.	616.	1008.	13[illegible].
		G3	382.	658.	1125.	1620.
XI. Middle East + North Africa	C	G1	117.	78.	40.	28.
		G2	120.	95.	47.	35.
		G3	122.	89.	52.	40.
	R	G1	59.	156.	273.	321.
		G2	60.	169.	316.	396.
		G3	61.	179.	348.	457.
	T	G1	176.	234.	314.	349.
		G2	180.	254.	363.	431.
		G3	183.	268.	400.	497.
XII. Other Africa	C	G1	581.	600.	532.	516.
		G2	609.	693.	669.	698.
		G3	633.	768.	780.	851.
	R	G1	129.	450.	931.	1240.
		G2	135.	520.	1171.	1676.
		G3	141.	576.	1364.	2342.
	T	G1	710.	1050.	1463.	1756.
		G2	745.	1213.	1840.	2374.
		G3	774.	1344.	2144.	2894.
World total (excl.Asian CPE countries)	C	G1	12727.	5368.	2499.	1300.
		G2	13156.	5659.	2609.	1617.
		G3	13388.	6227.	2862.	1883.
	R	G1	29105.	39054.	50232.	59643.
		G2	30285.	43655.	60598.	77109.
		G3	30868.	47140.	68737.	91503.
	T	G1	41831.	44442.	52531.	60943.
		G2	43442.	49513.	63207.	78725.
		G3	44256.	53367.	71598.	93386.

Notes: C = conventional tires
R = radial tires
T = total tires

Table A.42 Projections of demand for new tires (in thousands) for commercial vehicles

		code	scenario	1985	1990	1995	2000
I.	North America	C	G1	9437.	2709.	0.	0.
			G2	10614.	3321.	0.	0.
			G3	11625.	3787.	0.	0.
		R	G1	41805.	53734.	54157.	51098.
			G2	46757.	65730.	72927.	76266.
			G3	50900.	74830.	88041.	97965.
		T	G1	51242.	56443.	54157.	51098.
			G2	57372.	69051.	72927.	76266.
			G3	62525.	78617.	88041.	97965.
II.	Asia, developed	C	G1	5670.	2499.	1200.	0.
			G2	6090.	2914.	1532.	0.
			G3	6508.	3251.	1818.	0.
		R	G1	20451.	29212.	35225.	41755.
			G2	21826.	33709.	44012.	56081.
			G3	23164.	37366.	51455.	68698.
		T	G1	26121.	31712.	36425.	41755.
			G2	27916.	36623.	45544.	56081.
			G3	29672.	40617.	53273.	68698.
III.	Oceania,developed	C	G1	787.	269.	137.	0.
			G2	823.	300.	164.	0.
			G3	857.	326.	186.	0.
		R	G1	2137.	2655.	2720.	2830.
			G2	2223.	2948.	3245.	3663.
			G3	2304.	3187.	3687.	4397.
		T	G1	2924.	2924.	2856.	2830.
			G2	3046.	3248.	3409.	3663.
			G3	3162.	3513.	3874.	4397.
IV.	North-West Europe	C	G1	493.	0.	0.	0.
			G2	517.	0.	0.	0.
			G3	540.	0.	0.	0.
		R	G1	14533.	15300.	15726.	16625.
			G2	15252.	17077.	16673.	21068.
			G3	15948.	18508.	21160.	24994.
		T	G1	15026.	15300.	15726.	16625.
			G2	15769.	17077.	16673.	21068.
			G3	16487.	18508.	21160.	24994.

Table A.42 (cont.1)

		code	scenario	1985	1990	1995	2000
V.	South-West Europe	C	G1	731.	225.	0.	0.
			G2	782.	260.	0.	0.
			G3	832.	288.	0.	0.
		R	G1	5996.	6729.	7030.	7515.
			G2	6380.	7755.	8792.	10167.
			G3	6750.	8590.	10288.	12508.
		T	G1	6727.	6953.	7030.	7515.
			G2	7162.	8015.	8792.	10167.
			G3	7582.	8879.	10288.	12508.
VI.	Eastern Europe	C	G1	6255.	3827.	1954.	647.
			G2	6358.	3981.	2090.	715.
			G3	6458.	4107.	2206.	775.
		R	G1	7198.	9750.	11564.	12816.
			G2	7306.	10131.	12369.	14154.
			G3	7412.	10441.	13036.	15341.
		T	G1	13454.	13577.	13518.	13463.
			G2	13664.	14112.	14451.	14869.
			G3	13870.	14548.	15242.	16116.
VII.	Latin America + Caribbean	C	G1	6217.	4014.	2112.	777.
			G2	6439.	4399.	2466.	972.
			G3	6647.	4714.	2763.	1142.
		R	G1	7461.	10681.	13671.	16127.
			G2	7698.	11654.	15882.	20081.
			G3	7919.	12450.	17732.	23525.
		T	G1	13678.	14695.	15782.	16904.
			G2	14137.	16053.	18348.	21053.
			G3	14565.	17164.	20495.	24666.
IX.	South Asia	C	G1	1541.	1196.	1092.	823.
			G2	1625.	1360.	1331.	1083.
			G3	1707.	1494.	1531.	1312.
		R	G1	1118.	1948.	2651.	3568.
			G2	1177.	2208.	3226.	4680.
			G3	1233.	2420.	3709.	5654.
		T	G1	2659.	3143.	3743.	4390.
			G2	2802.	3568.	4556.	5764.
			G3	2941.	3913.	5240.	6967.

Table A.42 (cont.2)

	code	scenario	1985	1990	1995	2000
X. South-East + East Asia	C	G1	1956.	1198.	734.	453.
		G2	2063.	1358.	895.	594.
		G3	2164.	1499.	1029.	718.
	R	G1	3178.	5169.	6861.	9287.
		G2	3344.	5845.	8344.	12140.
		G3	3501.	6395.	9590.	14633.
	T	G1	5134.	6367.	7595.	9740.
		G2	5406.	7203.	9239.	12734.
		G3	5665.	7884.	10619.	15351.
XI. Middle East + North Africa	C	G1	910.	462.	248.	134.
		G2	955.	539.	299.	173.
		G3	986.	583.	339.	205.
	R	G1	1483.	2084.	2326.	2752.
		G2	1552.	2327.	2795.	3543.
		G3	1601.	2509.	3167.	4208.
	T	G1	2393.	2566.	2575.	2886.
		G2	2507.	2866.	3094.	3715.
		G3	2588.	3092.	3506.	4413.
XII. Other Africa	C	G1	4558.	3553.	3271.	2468.
		G2	4981.	4320.	4288.	3504.
		G3	5385.	4925.	5134.	4407.
	R	G1	3297.	5780.	7943.	10698.
		G2	3591.	6999.	10395.	15133.
		G3	3972.	7964.	12434.	18990.
	T	G1	7855.	9333.	11214.	13166.
		G2	8572.	11319.	14683.	18636.
		G3	9257.	12899.	17569.	23397.
World total (excl.Asian CPE countries)	C	G1	38558.	19972.	10748.	5301.
		G2	41247.	22755.	13064.	7041.
		G3	43709.	24963.	15007.	8560.
	R	G1	108655.	143040.	159873.	175070.
		G2	117106.	166382.	200650.	236977.
		G3	124604.	184662.	234297.	290912.
	T	G1	147213.	163012.	170621.	180371.
		G2	158353.	189137.	213715.	244018.
		G3	168313.	209625.	249305.	299472.

Notes: C = conventional tires
R = radial tires
T = total tires

Table A.43 Projections of rubber demand for passenger car tires (in thousand tons)

		scenario	1985	1990	1995	2000
I.	North America	a	1194.	1175.	1098.	1048.
		b	1239.	1236.	1153.	1095.
		c	1262.	1295.	1226.	1178.
		d	1297.	1330.	1248.	1189.
		e	1310.	1383.	1323.	1274.
II.	Asia, developed	a	160.	179.	178.	167.
		b	168.	182.	180.	167.
		c	165.	196.	196.	184.
		d	173.	198.	198.	183.
		e	178.	214.	216.	200.
III.	Oceania, developed	a	74.	76.	75.	74.
		b	76.	82.	80.	78.
		c	76.	84.	85.	84.
		d	79.	89.	88.	85.
		e	79.	92.	93.	91.
IV.	North-West Europe	a	530.	490.	450.	406.
		b	539.	501.	464.	420.
		c	553.	520.	488.	445.
		d	562.	529.	501.	456.
		e	578.	550.	528.	482.
V.	South-West Europe	a	214.	215.	212.	212.
		b	223.	231.	233.	241.
		c	225.	239.	241.	250.
		d	234.	251.	260.	280.
		e	236.	258.	267.	288.
VI.	Eastern Europe	a	139.	160.	186.	214.
		b	147.	184.	231.	285.
		c	147.	184.	231.	285.
		d	155.	203.	269.	348.
		e	155.	203.	269.	348.
VII.	Latin America + Caribbean	a	231.	287.	362.	441.
		b	249.	350.	502.	698.
		c	249.	350.	502.	698.
		d	268.	408.	639.	979.
		e	268.	408.	639.	979.

Table A.43 (cont.)

		scenario	1985	1990	1995	2000
IX.	South Asia	a	24.	31.	39.	46.
		b	25.	35.	46.	59.
		c	25.	35.	46.	59.
		d	27.	38.	53.	70.
		e	27.	38.	53.	70.
X.	South-East + East Asia	a	52.	79.	114.	170.
		b	54.	87.	135.	215.
		c	54.	87.	135.	215.
		d	56.	94.	153.	255.
		e	56.	94.	153.	255.
XI.	Middle East + North Africa	a	42.	49.	54.	60.
		b	45.	58.	72.	89.
		c	45.	58.	72.	89.
		d	47.	66.	87.	116.
		e	47.	66.	87.	116.
XII.	Other Africa	a	88.	107.	127.	147.
		b	90.	112.	136.	160.
		c	90.	112.	136.	160.
		d	91.	116.	143.	172.
		e	91.	116.	143.	172.
World total (excl.Asian CPE countries)		a	2748.	2848.	2896.	2984.
		b	2857.	3058.	3232.	3507.
		c	2893.	3160.	3359.	3646.
		d	2991.	3321.	3638.	4133.
		e	3027.	3421.	3770.	4275.

Table A.44 Projections of rubber demand for commercial vehicle tires (in thousand tons)

	scenario	1985	1990	1995	2000
I. North America	G1	1458.	1611.	1592.	1556.
	G2	1620.	1956.	2125.	2288.
	G3	1751.	2217.	2551.	2913.
II. Asia, developed	G1	421.	515.	601.	698.
	G2	448.	592.	748.	933.
	G3	475.	656.	872.	1139.
III. Oceania, developed	G1	82.	82.	82.	83.
	G2	85.	91.	97.	107.
	G3	87.	98.	110.	127.
IV. North-West Europe	G1	467.	482.	504.	531.
	G2	488.	534.	595.	670.
	G3	508.	577.	672.	791.
V. South-West Europe	G1	184.	193.	200.	214.
	G2	195.	221.	248.	286.
	G3	205.	243.	288.	349.
VI. Eastern Europe	G1	370.	377.	383.	389.
	G2	375.	391.	409.	429.
	G3	381.	403.	431.	463.
VII. Latin America + Caribbean	G1	205.	223.	244.	267.
	G2	212.	243.	283.	331.
	G3	218.	260.	316.	387.
IX. South Asia	G1	36.	43.	52.	62.
	G2	38.	49.	64.	81.
	G3	39.	54.	73.	98.
X. South-East + East Asia	G1	76.	96.	116.	150.
	G2	79.	108.	141.	196.
	G3	83.	118.	162.	235.
XI. Middle East + North Africa	G1	38.	42.	43.	48.
	G2	40.	47.	51.	62.
	G3	41.	50.	58.	73.
XII. Other Africa	G1	109.	135.	166.	199.
	G2	119.	164.	217.	281.
	G3	128.	186.	260.	352.
World total (excl. Asian CPE countries)	G1	3445.	3799.	3985.	4198.
	G2	3699.	4397.	4979.	5662.
	G3	3917.	4862.	5792.	6928.

Table A.45 Projections of NR demand for passenger car tires (in thousand tons)

	scenario	1985	1990	1995	2000
I. North America	a	349.	364.	344.	322.
	b	363.	383.	361.	337.
	c	370.	402.	384.	363.
	d	381.	413.	390.	366.
	e	385.	430.	414.	392.
II. Asia, developed	a	54.	63.	63.	59.
	b	57.	64.	63.	58.
	c	56.	69.	69.	65.
	d	59.	70.	70.	64.
	e	61.	76.	76.	70.
III. Oceania, developed	a	25.	28.	28.	27.
	b	26.	30.	29.	28.
	c	26.	31.	31.	31.
	d	27.	32.	32.	31.
	e	27.	34.	34.	33.
IV. North-West Europe	a	195.	182.	165.	148.
	b	198.	186.	171.	153.
	c	203.	193.	179.	162.
	d	207.	196.	184.	167.
	e	213.	204.	194.	176.
V. South-West Europe	a	79.	79.	77.	76.
	b	82.	85.	84.	86.
	c	83.	88.	88.	89.
	d	87.	92.	94.	100.
	e	87.	95.	97.	103.
VI. Eastern Europe	a	34.	45.	55.	66.
	b	36.	52.	69.	88.
	c	36.	52.	69.	88.
	d	38.	58.	80.	107.
	e	38.	58.	80.	107.
VII. Latin America + Caribbean	a	57.	84.	112.	138.
	b	62.	103.	155.	219.
	c	62.	103.	155.	219.
	d	67.	119.	198.	308.
	e	67.	119.	198.	308.

Table A.45 (cont.)

	scenario	1985	1990	1995	2000
IX. South Asia	a	12.	18.	24.	30.
	b	13.	20.	28.	38.
	c	13.	20.	28.	38.
	d	13.	22.	32.	45.
	e	13.	22.	32.	45.
X. South-East + East Asia	a	37.	62.	91.	138.
	b	39.	68.	108.	175.
	c	39.	68.	108.	175.
	d	40.	74.	122.	208.
	e	40.	74.	122.	208.
XI. Middle East + North Africa	a	12.	15.	17.	20.
	b	13.	18.	23.	29.
	c	13.	18.	23.	29.
	d	13.	21.	28.	38.
	e	13.	21.	28.	38.
XII. Other Africa	a	32.	47.	60.	74.
	b	33.	49.	64.	81.
	c	33.	49.	64.	81.
	d	34.	51.	67.	86.
	e	34.	51.	67.	86.
World total (excl. Asian CPE countries)	a	887.	987.	1035.	1097.
	b	922.	1058.	1155.	1293.
	c	934.	1093.	1198.	1339.
	d	966.	1147.	1298.	1521.
	e	978.	1182.	1342.	1568.

Table A.46 Projections of NR demand for commercial vehicle tires (in thousand tons)

	scenario	1985	1990	1995	2000
I. North America	G1	714.	859.	848.	800.
	G2	799.	1050.	1142.	1194.
	G3	871.	1196.	1379.	1534.
II. Asia, developed	G1	222.	285.	333.	386.
	G2	237.	329.	416.	519.
	G3	252.	365.	487.	636.
III. Oceania, developed	G1	41.	44.	44.	44.
	G2	43.	49.	52.	57.
	G3	44.	53.	60.	69.
IV. North-West Europe	G1	257.	265.	273.	288.
	G2	270.	296.	323.	365.
	G3	282.	320.	366.	433.
V. South-West Europe	G1	95.	101.	104.	111.
	G2	101.	116.	130.	150.
	G3	107.	129.	152.	184.
VI. Eastern Europe	G1	111.	132.	146.	156.
	G2	113.	137.	156.	172.
	G3	115.	141.	165.	186.
VII. Latin America + Caribbean	G1	68.	85.	102.	116.
	G2	70.	93.	118.	144.
	G3	72.	99.	132.	169.
IX. South Asia	G1	22.	28.	35.	43.
	G2	23.	32.	43.	57.
	G3	24.	35.	49.	68.
X. South-East + East Asia	G1	53.	72.	89.	116.
	G2	56.	81.	108.	152.
	G3	58.	89.	124.	184.
XI. Middle East + North Africa	G1	17.	21.	22.	26.
	G2	17.	23.	27.	33.
	G3	18.	25.	30.	39.
XII. Other Africa	G1	46.	70.	92.	120.
	G2	50.	85.	121.	170.
	G3	54.	96.	145.	213.
World total (excl. Asian CPE countries)	G1	1646.	1962.	2088.	2207.
	G2	1779.	2292.	2636.	3014.
	G3	1897.	2549.	3088.	3716.

BIBLIOGRAPHY

Allen, P.W. (1980): How long does a car tyre last, Rubber Developments, Malaysian Rubber Producers' Research Association.

Allen, P.W., P.O. Thomas, B.C. Sekhar (1973): The Techno-Economic Potential of NR in Major End Uses, Kuala Lumpur, Malaysian Rubber Research and Development Board.

Anderson, J.G. (1977): The rubber manufacturers' choice: natural or synthetic rubber, Plastics and Rubber International.

Association of Natural Rubber Producing Countries (1976): The agro-economic norm for natural rubber production, Kuala Lumpur.

Behrman, J.R. (1971): Econometric model simulations of the world rubber market in L.R. Klein, ed., Essays in Industrial Econometrics, vol. III, Philadelphia, Wharton School of Finance and Commerce.

Bonus, H. (1973): Quasi-Engel curves, diffusion and the ownership of major consumer durables, The Journal of Political Economy, vol. 81.

Bos, G.G.J. (1970): A Logistic Approach to the demand for private cars, Rotterdam University Press.

Brems, H. (1956): Long run automobile demand, The Journal of Marketing.

Button, K.J., A.S. Fowkes, A.D. Pearman (1980): Disaggregate and Aggregate Car Ownership Forecasting in Britain, Transport Research, Vol. 14A.

Cheong, T. (1972): An econometric model of the Malaysian rubber industry , unpublished Ph.D. dissertation, London School of Economics and Political Science.

Chow, G.C. (1957): Demand for automobiles in the United States, a study in consumer durables, North-Holland Publishing Company.

Chow, G.C. (1960): Statistical demand functions for automobiles and their use in forecasting, in A.C. Harberger (ed.), The demand for durable goods, University of Chicago.

Cramer, J.S. (1959): Private motoring and the demand for petrol , in Journal of the Royal Statistical Society, A 3.

Cramer, J.S. (1968): Autoverkopen en autopark in Nederland, 1950-1970", Statistica Neerlandica 22, No. 2.

Davis, H.T. (1941): The Theory of Econometrics, Bloomington, Principia Press.

Dicks-Mireaux, L.A., C.St.J.O'Herlihy and others (1961): Prospects for the British Car Industry, National Institute Economic Review 17.

Diekmann, A. (1974): Future trends in the motor industry, Study prepared for the Verband der Automobilindustrie, Frankfurt.

Economic Intelligence Unit, Rubber Trends, London, several issues.

Economic Intelligence Unit (1976): Rubber and the Automotive Industry in the U.K. and North America, London.

Economic Intelligence Unit (1978): The world rubber market and prospects for stabilisation, London.

Economic and Social Commission for Asia and the Pacific, H.P. Smit (1978): Projections of demand for rubber, Bangkok.

Fauré, H. (1959): Un modèle prospectif du marché de l'automobile, Consommation (Annales du C.R.E.D.O.C.).

Grilli, E.R., R. Helterline, P. Pollak (1978): An econometric analysis of the world rubber economy, World Bank Staff Commodity Paper 3, Washington D.C.

Grilli, E.R., B. Bennett Agostini, M.J. 't Hooft-Welvaars (1980): The world rubber economy, World Bank Staff Occasional Papers 30, John Hopkins University Press.

Horowitz, I. (September 1963): 'An econometric analysis of supply and demand in the synthetic rubber industry , International Economic Review, vol. 4, No. 3.

IBRD/FAO (1978): The world rubber economy: structure, changes, prospects Washington, D.C.

International Institute of Synthetic Rubber Producers, Inc. (1977): International Statistical Review of the Synthetic Rubber Industry, New York.

International Road Federation, World Road Statistics, Washington D.C., several issues.

International Rubber Study Group, Rubber Statistical Bulletin, London, several issues.

International Rubber Study Group (1978): Proceedings of the 25th Assembly, Washington D.C.

International Rubber Study Group (1979): Proceedings of the 92nd Meeting, London.

International Rubber Study Group (1980): Proceedings of the 26th Assembly, Kuala Lumpur (forthcoming).

Jacobson, L.(1973): Car Forecast for Sweden, 1972-1985, Stockholm, National Institute of Economic Research.

James, G., R.C. James (1968): Mathematics Dictionary, third edition, New York, Van Nostrand-Reinhold Books.

Japan Automobile Tire Manufacturers Association (1975): Report by the Statistical Committee, Tokyo.

Juster, F.T. and P. Wachtel (1972): Anticipatory and objective models of durable goods demand, The American Economic Review, Vol. 62.

Kolbe, H., H. Timm (1972): Die Bestimmungsfaktoren der Preisentwicklung auf den Weltmarkt für Naturkantschuk, HWWA-Institut für Wirtschaftsforschung, Hamburg.

Lehbert, B. (1962): Die Nachfrage nach Personenkraftwagen in der Bundesrepublik Deutschland,Kieler Studien, J.C.B. Mohr, Tübingen.

Mood, A.M., F.A. Graybill and D.C. Boes (1974): Introduction to the Theory of Statistics, third edition, McGraw Hill.

Morice, J. (1957): La demande d'automobile en France, Librairie Armand Colin, Paris.

National Academy of Sciences (1977): Guayule, an alternative source of natural rubber, Washington D.C.

Nerlove, M. (1960): The market demand for durable goods: a comment, Econometrica, vol. 28.

Nowicki, A.G. (1969): Establishment and development of automotive industries in developing countries , part II of the report and proceedings of a seminar ar Karlovy Vary.

O'Herlihy, C.St.J. (1965): Demand for cars in Great Britain , Applied Statistics, Journal of the Royal Statistical Society, C, vol. 13.

Reutens, A. (1974): An econometric Analysis of the International Rubber Economy, University of Illinois.

Roos, C.F., V. von Szelisky (1939): Factors governing changes in domestic automobile demand, in: The dynamics of automobile demand, General Motors Corporation, New York.

Ruebensaal, C.F. (1977): Changing Markets and Manufacturing patterns in the synthetic rubber industry, International Institute of Synthetic Rubber Producers' 18 Annual Meeting, Monaco.

Sekhar, B.C., T.Y. Pee (1980): Natural Rubber potentials for the future, Malaysian Rubber Research and Development Board, Kuala Lumpur.

Smith, R.P. (1975): Consumer demand for cars in the USA, Cambridge, University Press.

Stone, R., D.A. Rowe (1957): The market demand for durable goods, Econometrica, vol. 25.

Stone, R., D.A. Rowe (1958): Dynamic demand functions: some econometric results, The Economic Journal, vol. 68.

Stone, R., D.A. Rowe (1960): The durability of consumers' durable goods, Econometrica, vol. 28.

Suits, D.B. (1958): The demand for new automobiles in the United States 1929-1956, The Review of Economics and Statistics, vol. 40.

Swan, P.L. (1971): Natural rubber trade: the implications of synthetic rubber innovations , Applied Economics, vol. 3.

Thomas, P.O. (1970): Malaysian NR in the seventies, Planters' Bulletin, Rubber Research Institute of Malaya, Kuala Lumpur.

Thomas, P.O., P.W. Allen (1973): Some aspects of competition between natural and synthetic rubber , Rubber Research Institute of Malaysia, Planters' Conference, Kuala Lumpur.

Ueno, Hiroya and Hiromichi Muto (1971): A dynamic demand-supply model of the Japanese automobile industry, 1955-1966' in L.R. Klein (ed.), Essays in Industrial Econometrics, vol. III, Philadelphia, Wharton School of Finance and Commerce.

United Nations, Annual Bulletin of Transport Statistics for Europe, several issues.

United Nations, Monthly Bulletin of Statistics, several issues.

United Nations, Statistical Yearbook, several issues.

United Nations Population Division (6 October 1975): "Single-year population estimated and projections for major areas, regions and countries of the world, 1950-2000", ESA/P/WP.56, revised in early 1976.

United States Motor Vehicle Manufacturers Association, Motor Vehicle Facts and Figures, Washington D.C., several issues.

Vermetten, J.B. (1964): Prognose van het autopark met behulp van een 'diffusion-model' , Statistica Neerlandica 18, 1004.

Voss, W. (1970): Bestimmungsgründe der Preisentwicklung auf dem Weltkautschukmarkt , Hamburg, HWWA, Institut für Wirtschaftsforschung.

Walker, F.V. (1968): Determinants of autoscrappage, The Review of Economies and Statistics.

Williams, R.A. (1972): Demand for consumer durables: stock adjustment models and alternative stock adjustment models and alternative specifications of stock depletion in Review of Economic Studies.

Wolff, P. de (1938): The demand for passenger cars in the United States, Econometrica, vol. 6.

"World vehicles production and sales, forecasts to 1985 by major country and manufacturer" (1975), in Euroeconomics, Frankfurt.

Wijkoff, F.C. (1970): Capital depreciation in the postwar period: Automobiles, The Review of Economics and Statistics.

Serie Research Memoranda:

1977-1	L. Hordijk, P. Nijkamp,	Estimation of Spatiotemporal Models -New directions via distributed lags and Markow schemes.
1977-2	P. Nijkamp,	Gravity and entropy models: The state of the art.
1978-1	J. Klaassen,	Valuta problemen in de Jaarrekening.
1978-2	P. Nijkamp, M.W. van Veenendaal,	Psychometric scaling and preference methods in spatial analysis.
1978-3	P. Nijkamp, J. Spronk,	Interactive Multiple Goal Programming.
1978-4	P. Nijkamp, P. Rietveld,	New Multi Objective Techniques in Physical Planning.
1978-5	P. Nijkamp,	Decision Models for Planning against Stagnation.
1978-6	P. Nijkamp,	A Theory of Displaced Ideals. An Analysis of Interdependent Decision via Non-Linear Multi-Objective Optimization.
1978-7	P. Nijkamp,	Conflict Patterns and Compromise Solutions in Fuzzy Choice Theory. An Analysis and application.
1978-8	J.D.P. Kasper,	De Bijdrage van Detailhandelsmarketing aan Maatschappelijke Welvaart en Welzijn.
1978-9	H.J. Blommestein, P. Nijkamp, P. Rietveld,	A Multivariate Analysis of Spatial Inequalities.
1978-10	F. Palm and A. Zellner,	Large Sample Estimation and Testing Procedures for Dynamic Equation Systems.
1978-11	J.H.T.H. Andriessen, P.A. Cornelis, H. van der Flier,	Participatie, Invloed, Satisfactie en Groepseffectiviteit. Een onderzoek bij deelnemers aan een bedrijfsspel.
1978-12	W. van Lierop and P. Nijkamp,	A utility framework for interaction models for spatial processes.
1978-13	R.J. Joseph,	Beschermingsconstructies in het huidige en komende vennootschapsrecht.
1978-14	P. Nijkamp en W. van Veenendaal,	A multi-attribute analysis of spatial choice Behaviour.
1979-1	A.A. Schreuder-Sunderman, Frans Blommaert en Hein Schreuder,	Werknemers en Soc. Jaarverslag.
1979-2	H. Schreuder,	De maatschappelijke verantwoordelijkheid van Ondernemingen.
1979-3	P. Nijkamp en P. Rietveld,	Multilevel Multi-objective Models in a Multiregional System.
1979-4	J. Arntzen, G. Bornmalm-Jardelöw and P. Nijkamp,	Duality, Segmentation and Dynamics on a Regional Labour Market.
1979-5	P. Nijkamp, A. Soffer	Soft Multicriteria Decision Models for Urban Renewal Plans.
1979-6	drs. A.J. Mathot	A Model of choosing a car with or without a credit.
1979-7	H. Blommestein, P. Nijkamp en W. van Veenendaal,	Shopping Perceptions and preferences: A multidimensional Attractivenerss Analysis of Consumer and Entrepreneurial Attitudes.
1979-8	H.J.Blommestein and F.C. Palm	The Aggregate Demand for Money in the Netherlands-a new look at a study of the Bank of the Netherlands.